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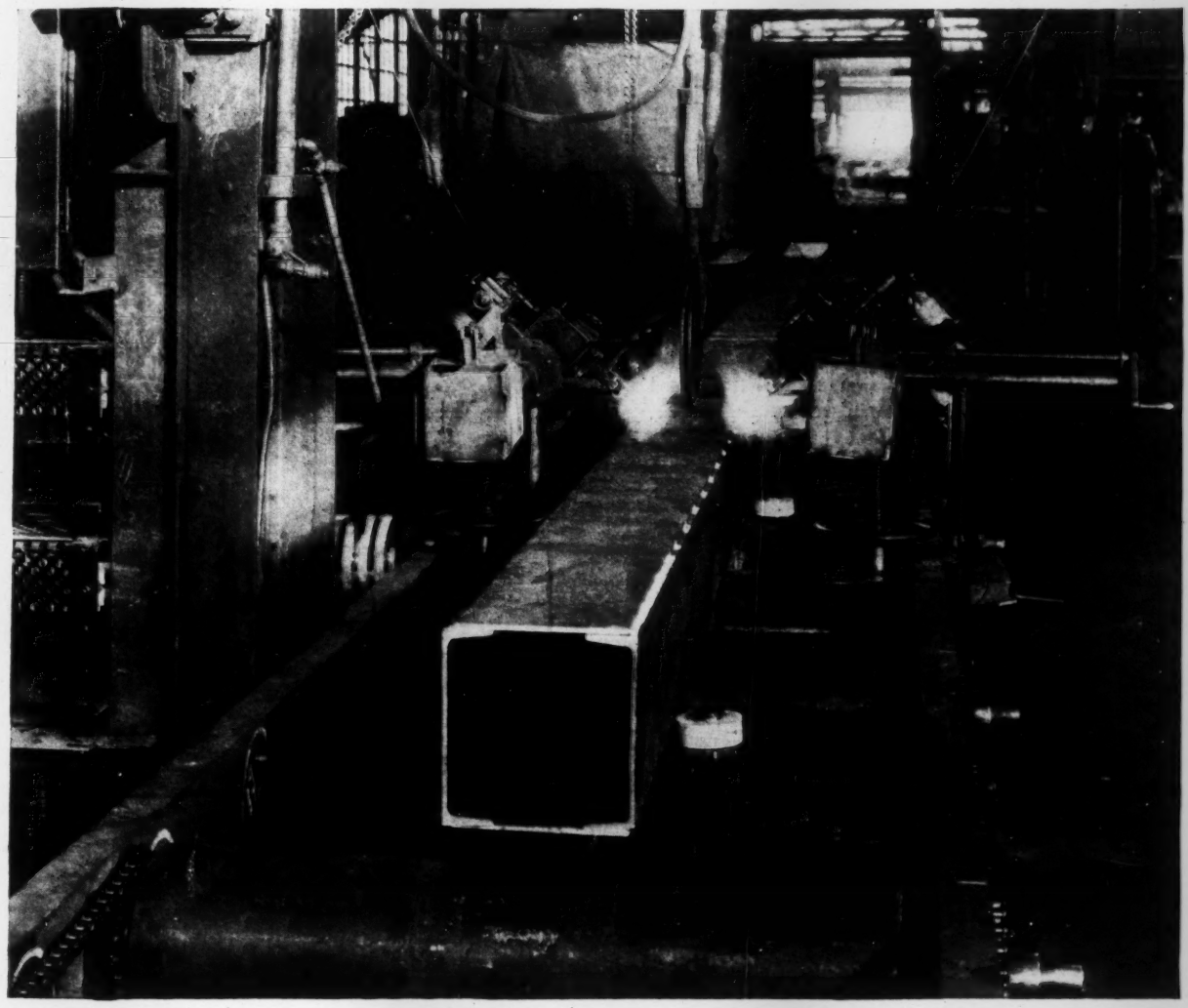

Fabricating Structural Steel Sections by Automatic Arc-Welding

First of Two Articles on...

MODERN CEMENTS

By P.H. BATES, U.S. Bureau of Standards

New cements, the most interesting development in the field of construction materials, are discussed by an acknowledged authority. Mr. Bates tells why the single portland standard is being abandoned after a quarter-century's supremacy. He sets forth the characteristics of cements and cites test results.

First ONE - *then the* OTHER *of these Sports Buildings*

Yost Field House (University of Michigan), one of the prominent athletic buildings of the country, was roofed with Federal Red Interlocking and Glass Tile some years ago. The *new* Intra-Mural Sports Building, designed by the same architects and engineers, now being completed, carries the same type of Federal tile, which serves so well on Yost Field House.

There is no other roof so perfectly fitted for sports buildings, gymnasiums, auditoriums, schools, theatres—all public buildings—as Federal. Precast of concrete, it is absolutely safe against fire, offering essential protection to the men, women and children, beneath the roof.

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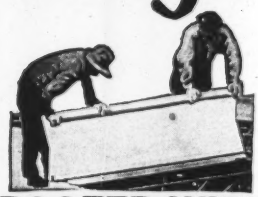
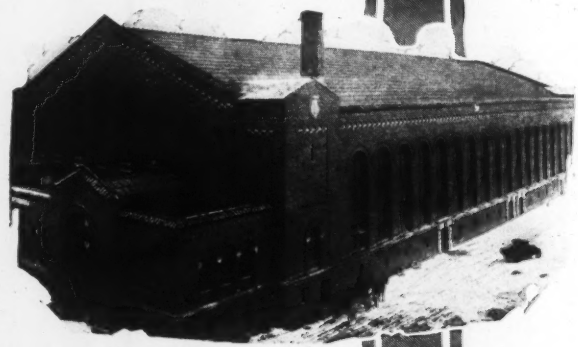
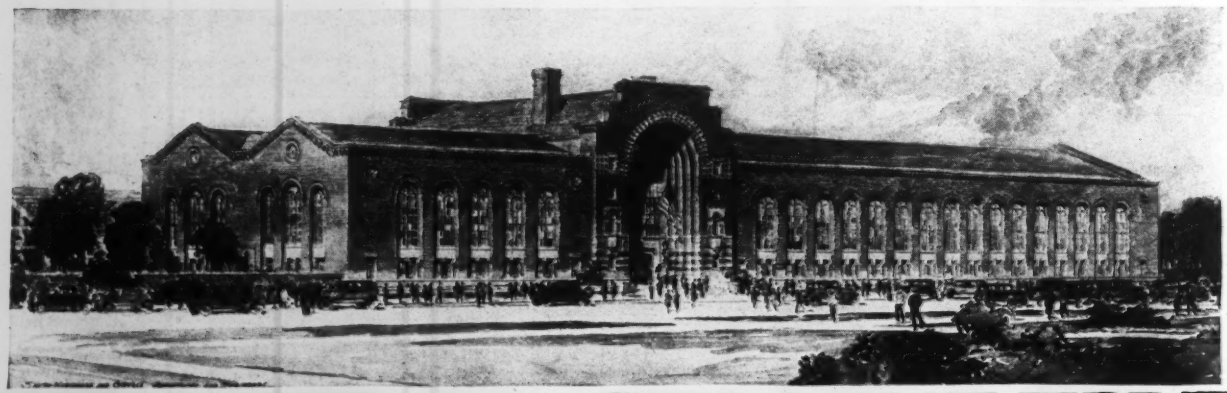


ROOFED WITH FEDERAL

No Building Can Be Firesafe Without a Fireproof Roof



Above, the first University of Michigan Sports Building (Yost Field House) and below, the new one, now being completed, both of which are covered with Federal Red Interlocking Tile, and Glass Tile for daylighting.



FEDERAL CEMENT TILE

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Hurried Legislation

EVERY fourth year the business of managing that great corporation which we call the United States suffers a serious disturbance because Congress insists on hurrying its legislative work through to an early end so that it may adjourn well before the party conventions of the presidential campaign. By thus hurrying the current session, it has managed to leave the impress of haste and superficiality on most, if not all, of the work it did. Two of the great constructive problems included in its deliberations—namely, Mississippi River flood control and regulation of the Colorado River by a storage reservoir at Boulder Canyon—testify eloquently to this fact. Most characteristic of the situation was the handling of the Mississippi matter. Protracted hearings, essentially uninforming, and for that matter uninquiring, were followed by extended but greatly hurried political jockeying, in which the President's office played an unusual legislative rôle. Mr. Coolidge sacrificed his announced principle, that of equitable payment for benefits, and saved only his prejudice—namely, subordination of the Mississippi River Commission to bureaucratic Washington administration. This result, whether it be good or bad, became possible only through a large-scale abdication of independent legislative judgment on the part of Congress, and this in turn may be traced to its desire for early adjournment. For this regrettable result, the just-concluded session of our national legislature deserves to be remembered.

Boulder Canyon

LOOKING back over its several years of existence as a national project, the Boulder Canyon development will be seen to have made more significant progress in this session of Congress than in any prior one. The bill for its construction not only obtained favorable committee reports but it was passed by the House. It failed in the Senate by reason of end-of-the-session pressure, again the outcome of a desire to hurry through to an end regardless. As heretofore, the opposition fight against the measure was chiefly made by Arizona representatives, and quite naturally so, since the ill-starred Colorado River compact which the bill undertakes to legitimatize would leave Arizona almost emptyhanded in the matter of water from the river. But it was made evident in the discussions that the state is concerned as much about deriving an income from the power byproduct as about obtaining water. That the bill could make so much progress in the face of this obstacle reflects the increasing seriousness of the problem, in which not only is the formidable difficulty of the delta left unsolved but also the whole development of the river remains paralyzed. The present plan is to take the bill up again early in December, and its further progress in the Senate at that time will be a matter for interested contemplation. In the meantime, a full study of the whole problem is to be made by a board of engineers and geologists. If the findings of this board should give consideration to the economic as well as to the technical aspects of the project, they will be doubly valuable.

Sliding Versus Scouring

INTERESTING matter for speculation offers itself to both geologists and engineers in the novel views of the St. Francis dam failure reported to the Ventura County authorities. We are able to reproduce them in very brief abstract only, but fully enough, we hope, to set forth clearly the ingenious theories advanced. It is to be borne in mind that attempts to explain an unseen happening from scattered bits of evidence found in a vast mass of wreckage are inevitably affected by a high degree of uncertainty, and "conclusions" can hardly claim to be more than individual opinions. The present views traverse the unanimous verdict of all the other expert boards of investigation, which held that the failure was due to washout of soft foundation strata in the right hillside. They substitute sliding and overturning for underscouring. They place the seat of the failure on the left bank, premising an unusual geological disturbance and a tremendous cantilever strength in the structure of the dam at locations where shrinkage cracks had existed. Further, in drawing far-reaching conclusions from the appearance of a wooden ladder caught in a crack in the remaining section of the dam, the report plays rather heavily on a single bit of circumstantial evidence—and circumstantial evidence, we know, must always be handled with great caution. But, taken in its entirety, the report reinforces the findings of the earlier reports in saying that the foundation was thoroughly unsuitable and unsafe. It thus stresses even more gravely the critical importance of soil foundation study in connection with important dams. And in its declaration that the site, being located across a geological fault, was inherently a wrong one for a large dam, it brings up a question that is bound to be of primary importance in future discussion of dams.

Officers of the Law

THERE are laws in all states prohibiting the use of glaring head lamps by motor vehicles, but it is notorious that these laws are widely ignored. Every road user knows that uncounted numbers of blinding head lamps are tolerated, and every one has occasion to read periodically of killings and maimings that result from this practice. Last week, for example, a loaded motorbus was wrecked through the effect of blinding lamps on another vehicle, and this accident is merely one successor of an endless procession of prior accidents. Are these conditions chargeable to engineering shortcomings? By no means, for many excellent head lamps can be found and are in use. The toleration of unsafe lamps (and unsafe lamp users) is wholly the fault of the enforcement offi-

cials, men who are armed with an adequate law and sworn to execute its mandates but who consistently fail so to do. The time will come, we predict, when these enforcement officials will be called to account and made to answer for neglect of duty. Perhaps the time is here now. No single improvement in safety conditions on the road is as urgent as elimination of glare and improvement of light visibility.

Air Progress

DRAMATICALLY and steadily progress in air transportation continues. As the world marvels at the daring and skill of Captain Wilkins in flying a single-motored monoplane 2,200 miles across the top of the world, another plane glides down from a Fiji Island sky on the second leg of a transpacific flight to Australia. Simultaneously, the dirigible "Italia" disappears in the frozen Arctic wastes and adds a note of warning to the adventurous. And in the midst of it all the U. S. air-mail service quietly and characteristically celebrated its tenth birthday. Ten years ago last month the first air mail was flown between New York and Washington, using army planes and army pilots. In the ensuing decade the air-mail service has become the envy of every nation. Originally government managed, every one of its 22 routes is now operated under contract, by private capital. An accounting on May 8 showed routes in service totaling 10,058 miles, over which mail pilots daily cover 22,448 miles. Governmental co-operation, similar to that which has long provided harbor facilities for shipping, has resulted in 7,500 miles of lighted airways for night flying. The accounting further reveals that nine transport companies in 1927 flew 37,000 passengers some 500,000 airplane-miles. And as final evidence that there is being born an air-transport industry, an Eastern trunk line railroad announces a combination air-rail service from coast to coast. To the civil engineering profession, this air progress means not only new opportunities to enjoy but new obligations to fulfill. All the obligations that will be imposed are not yet wholly defined. Some of them, coincident to the surveying and lighting of airways and the layout and construction of such simple airport facilities as have so far been planned, are being met. But the air-age has not yet fully made known its ultimate requirements in engineering structures and services.

Federal Reclamation Bankrupted

RECENTLY we outlined the situation involved in a bill which proposed to give "relief" to the Rio Grande reclamation project by extending the time of repayment on the part of the land owners from 20 to 30 years. Since that time the bill has become law, being passed by Congress and signed by the President, in spite of its utterly indefensible character. Its enactment means not a mere postponement of repayment but, since only the principal is repaid, without interest, it means the donation of national funds to the people of one small locality. Were these people in actual need, something could be said for this peculiar type of philanthropy, but that is not the case. The bill constitutes a complete and deliberate bankrupting of federal reclamation, an enterprise which was conceived as a sound and constructive measure of national development but has been degraded into a mere pork-barrel device. The system now remains only a thinly veiled disguise for the diversion of public money to the pockets of Western land speculators. It would be better for the national government to donate the money direct to the Western states and let them take the onus of expending it for the construction of unsound irrigation projects. Even in a highly fertile region, favored by climate as is the Rio Grande project, irrigation farming is proved to be a losing venture, one which requires periodical charity contributions from Washington; how much more hopeless, then, to apply many millions to the irrigation of barren tracts in cold northern regions at far higher unit cost! No member of Congress would undertake such a venture as his own enterprise, yet he will vote that the Nation undertake it. Such a type of business management for the country can stir no cheerful reflections. At best, it leads to the conclusion that the sooner reclamation is finally abolished, the better.

An Engineering Obligation

FAILURES of dams have ever exerted a peculiar fascination of horror on men's minds. Accordingly there is far greater concern for the safety of dams than for that of other human works. If engineers as a class are less susceptible to these emotions, it is yet their duty to take note of the attitude of the popular mind. Thus the failure of the St. Francis dam awakened widespread apprehension concerning other dams and many investigations were started to make sure that existing dams are secure. In strange contrast with this agitation, there has been very little activity on the subject of dam safety among engineering organizations. Are they fully awake to their manifest obligations?

When public sentiment becomes aroused, the circles directly affected cannot wisely remain inactive. The politician knows this well, and the whole of the present-day study of public relations lays emphasis upon it. The engineer is less delicately attuned to "the voice of the people," perhaps; yet there are times—as now—when the profession would benefit by having such intuitions.

Legislation affecting the construction of dams invites the close attention of engineers. The laws of California, for example, are such that the St. Francis dam legally could be—and was—built without a permit of any sort and without the necessity for checking in any way the judgment of the one engineer who planned and directed the work. There is popular demand for a change in the California law affecting dam construction and indications all point to the early enactment of new laws or at least changes in existing statutes. In other states legislative changes may be needed or, forsooth, whether needed or not such changes may be thrust upon the public, including the engineering profession, as the result of the popular sentiment aroused by the St. Francis disaster. Shall the layman frame these laws, or shall the engineer take his proper part in the work?

Such legislation is of far-reaching importance and should not hastily be passed. Whether full restrictive and supervisory powers should be vested in state officials or whether that authority in some way should be delegated to a board or boards of engineers specially selected in the case of important structures is a question that needs to be studied and analyzed. Despite this situation in which engineers are so vitally concerned, so far as we know there has been no sign of activity on the part of engineers to forestall undesirable legislation or to aid in shaping good laws.

This is a public service that the engineer could and should render; no one is so qualified as he to point out the dangers and to lead the way. Unfortunately, he is more inclined to stand modestly aside while others take the lead. Many weeks ago, or as soon after the disaster as the probability of legislative changes became apparent, engineering societies should have appointed committees of their best qualified members to consider the legislative questions involved. Such committees could at least outline the engineering aspects of the situation and thus give to their commonwealth the benefit of a trained, practical point of view.

It is not yet too late for such action, but the opportune time will soon be passed. It would be unfortunate, indeed, if action by engineering societies were delayed until legislative bodies have before them one or more proposed bills relative to control of dam construction, submitted and backed by interests of one sort or another. Coming at that late date, a recommendation from engineering organizations would appear as an "opposition measure" and would be combated as such. Now is the time for real leadership and now is the time to act.

Contractors and the New Levees

THE organization of a levee division of the Associated General Contractors indicates that contractors are awake to the interest to them that lies in the stupendous task of Mississippi flood control which is to be undertaken by the United States. Are they equally awake to their responsibilities toward this great construction task?

Their works will tell. But the time is short before the proof of works will be demanded, and there is no evidence that the contracting business is ready with this proof. Unless contractors by and large appreciate the nature of the construction task which the new Mississippi levees impose, unless they are alert to the fact that old methods and old equipment will not suffice, they will fail of their manifest obligation.

It is not necessary to demonstrate again that new problems in earth moving are inherent in the greater levees which are now planned. The articles by W. W. De Berard which have been running through these pages for months leave untold no important part of the story. They indicate that if the work is to be done with speed and economy there must of a certainty be new methods planned and new machines devised. Those at hand are neither sufficient nor efficient. These facts need to be often repeated. They put a duty on contracting far more pressing than any degree of broadsiding its inherent rights to do construction: the duty of demonstrating that it possesses the right given it by superior ability to devise and create unprecedented ways and means of moving earth into embankments.

If the contractors of the country hope to have pre-eminence in building the Mississippi flood works, they must show pre-eminent ability to develop methods and machines superior to those now being employed. If organized contracting is to show that it has a vital function in the construction industry, it must take leadership in inspiring this creative planning by its membership. The mere utterance of a bill of rights will not obtain for the contracting industry its full heritage from Mississippi flood control—profits earned and service rendered. It must justify its heirship by demonstrating leadership in construction skill.

A Coming Development

BARELY half a dozen years have passed since the beginnings of that remarkable stirring in the world of cement which motivates P. H. Bates' discussion of modern cements, in this issue. Five or six years ago "cement" meant just one thing—namely, standard portland cement, commonly held to be the same thing whether shipped from a Pennsylvania or from a Kansas mill. Today there are many special cements, each putting forward claims of such appeal to the engineer that he feels bound to give them serious consideration in his construction programs. And what from one point of view is fully as important, it is widely believed today that different makes of "standard" portland differ materially in their properties, and test figures seem to substantiate the belief. These new conditions presage coming developments of great importance.

It is too early to perceive the ultimate trend of the change that has begun. Its inception is traceable to the simple reason that the demands we put upon cement are marvelously many-sided, so much so as to make it all but impossible to attain the best answer to all demands in one single product. Whether special products can meet them more effectively in the long run is yet to be demonstrated, for cement and concrete are materials whose major test is furnished by time alone. But for the present it is apparent that the making and using of special cements will continue and will grow.

But development cannot progress far, or progress soundly, until knowledge of cement and of the testing of cement is greatly improved. Under present conditions, in fact, this improvement of knowledge is the most important need of the entire field. The test figures which we obtain and interpret have only vague meaning.

When two "standard" cements show quite different strengths in the laboratory, we are unable to say that one cement is "better" than another, for excellence and test results are not yet satisfactorily correlated. And it is also to be remembered that, though we test cement, we are really interested in concrete, and even tests of concrete cylinders do not fully inform us. They do not tell us what the tests made in a month's time mean with respect to long-time behavior, and they do not tell us whether the particular aggregate mixture tested brings the best possibilities of the cement into action. When we find a series of duplicate tests exhibiting wide variations, we are unable to tell whether they are attributable to the material or to the test method, and in consequence we are forced to content ourselves with coarse averages of long series of tests.

These are not conditions that favor the isolation and appraisal of individual factors and influences in the material. Until greatly improved knowledge of testing is obtained, we can hardly do more than grope, in the attempt to make progress in cement. And, again, until the nature of cements and the whole history of their chemical and physical life are more fully known, the art must remain on an empirical, cut-and-try basis.

The cement field is one which will of necessity enlist much ability and much labor for its study in the early future. Already the effort being given to such study is showing a noteworthy increase. Through this investigational work, supplemented by the teachings of practice, a new cement era is sure to be developed, of greater powers and wider service to mankind than that of the past three decades.

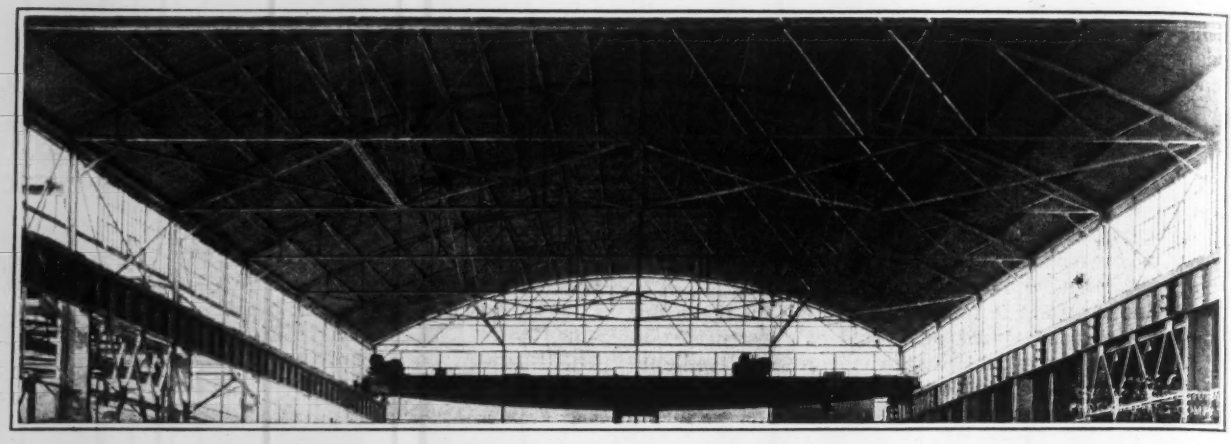

Fig. 1—Welded Roof Trusses; 83-Ft. Span
Note absence of gussets, web members being welded to upstanding legs of chords.

Welded Construction for Large Shop Building

Special Automatic Welding Machine Fabricates Built-Up Columns and Girders—83-Ft. Welded Trusses Also Used in Main Bay of 340x135-Ft. Building

ARC-WELDED steel construction for a shop building and yard craneway, with built-up members welded by an automatic machine of new design, is a notable development in the new plant of the Mississippi Valley Structural Steel Company at Melrose Park, Ill., near Chicago. The welding includes built-up columns, large and small roof trusses, plate girders and a variety of details in stairs, hand rails and shop appliances. This company is making extensive use of welded instead of riveted construction for trusses, roof supports, lintels and other structural members.

This new plant, covering nearly twenty acres, has a punch shop 150x150 ft., a warehouse 340x135 ft. and at right angles to the latter a riveting and assembling shop 85x125 ft. A 20-ton overhead crane of 80-ft. span extends the length of the warehouse and similar cranes traverse the assembly shop and the shipping yard, this last having a runway 200 ft. long. Welded construction was employed throughout for the warehouse, but for the punch shop riveted construction was used, since the curved-chord trusses had to be designed to carry a series of light traveling cranes and their make-up did not lend itself to convenient or economical welding. Figs. 1 and 3 show the welded columns, girders and roof trusses of the warehouse.

Welded Framing for Warehouse — This building, whose general design is shown in Fig. 2, has four rows of columns spaced 27 ft. 8 in. c. to c. longitudinally and forming a lofty 80-ft. central bay with lower 26-ft. side bays, the clear height from floor to truss being 34 ft. in the main bay and 15 ft. in the side bays. Longitudinal bracing includes vertical and horizontal diagonals between the trusses, the crane runway girders and diagonal cross-bracing between the columns in some of the panels. The light framing of the walls is attached to brackets or clips welded on the columns. Corrugated steel sheathing is used for the sides and roof, except that continuous steel sash is used above the low side roofs. Steel sash is used also for windows in the side and end walls.

Welded construction was used in building the columns, plate girders, roof trusses and trussed purlins. Field welding was employed in attaching the craneway girders to the columns and in uniting the two halves of each 80-ft. truss on the ground before erection, these trusses being delivered in 40-ft. welded lengths. Field connections for bracing were generally assembled by bolting and then riveted, as this was more convenient for erection. The trusses would have to be bolted temporarily, to hold them in place, and waiting while welded connections were made would have delayed erection.

Welded Columns—Built-up columns for the 80-ft. bay, Fig. 4, have the lower part composed of a web plate $20x\frac{5}{16}$ in., with a 9-in. I-beam for the inner flange and an 8-in. channel for the outer flange. This latter extends the full height of the column, 34 ft. The I-beam extends to a height of $21\frac{1}{2}$ ft. and is capped by a plate forming a seat for the crane girder. Above this the web plate is only 7 in. wide, and its inner flange is a plate $6x\frac{3}{8}$ in., forming a T-section. At its lower end this flange plate is slotted to engage the main web plate. The web plates are welded continuously to the flanges. To provide lateral strength, reinforcing the thin seam connecting the web to the flange, short diagonal bars $1\frac{1}{2}x\frac{3}{8}$ in., about 18 in. apart and staggered, have their ends welded to the web plate and the flanges of the I-beam and channel and to the flange plate of the top or extension web.

The main web plate extends above the girder seat to form a gusset, against which the ends of the girder webs are butted. These three plates were field welded together as a solid connection. No expansion joint is provided in the 340-ft. length of craneway. The columns of the walls and ends are not built up, but are rolled channels or I-beams.

Welded Plate Girders—These craneway girders, Fig. 5, in lengths of 27 ft. 8 in., consist of a web plate $36x\frac{3}{8}$ in. with a plate $12x\frac{9}{16}$ in. for the bottom chord and a 15-in. I-beam, laid flat, for the top chord. The web stiffeners are plates $4x\frac{3}{8}$ in., spaced about 4 ft. apart and welded to the web and chords. An 80-lb. rail for the crane is laid on the web of the I-beam and secured partly by bolted clips and partly by $\frac{3}{4}$-in. rods, whose ends are welded to the web of rail and flanges of I-beams. Bent plates field riveted to the bottom chord form attachments for the longitudinal diagonal braces.

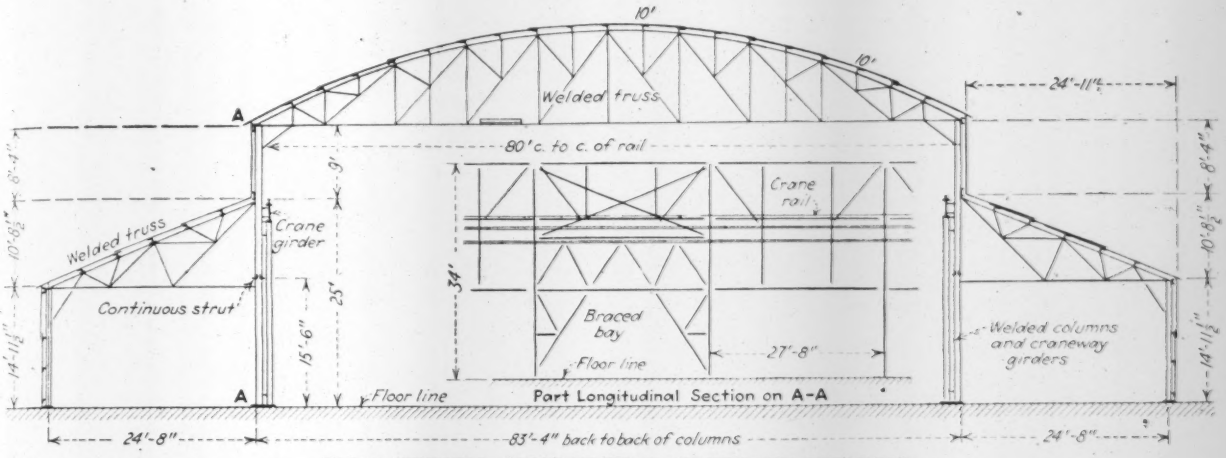

FIG. 2—TYPICAL CROSS-SECTION OF WELDED BUILDING
Insert, on smaller scale, shows typical longitudinal framing, including one braced panel.

Welded Roof Trusses—In the 80-ft. trusses for the central bay, Figs. 1 and 6, the chords are pairs of angles welded together at intervals to make a T-section. At the ends the vertical legs of chords are cut to form a butt joint which is welded for its entire length, while under the bottom chord are welded bearing plates which are riveted to the cap plates of the columns.

Web members are composed of single or double angles having their ends welded to the legs of the chord angles. No gusset or connection plates are used, as in riveted trusses, and the absence of these improves the appearance of the finished roof. In erection, the welded trusses were found to be stiffer than riveted trusses of the same general size and type. The truss weighs about 2½ tons, ready for erection. Its depth is 11 ft. at the middle, and its top chord has a radius of about 83 ft., or the exact length of the span.

The 26-ft. triangular trusses of the side bays are also welded, built up of light angles. They are field riveted to the wall columns and to the sides of the tall columns of the central bay.

Yard Craneway—For loading material in the shipping yard, there is a 20-ton traveling crane of 80-ft. span on a runway of somewhat similar construction to the warehouse framing. The columns, Fig. 4, extend above the runway girders and have caps and connections welded in, so that a roof can be placed later and shop painting done here under cover. In these columns, however, both flanges are 12-in. channels, instead of having an I-beam for the inner flange, while the web plate is 22x$\frac{5}{16}$ in.

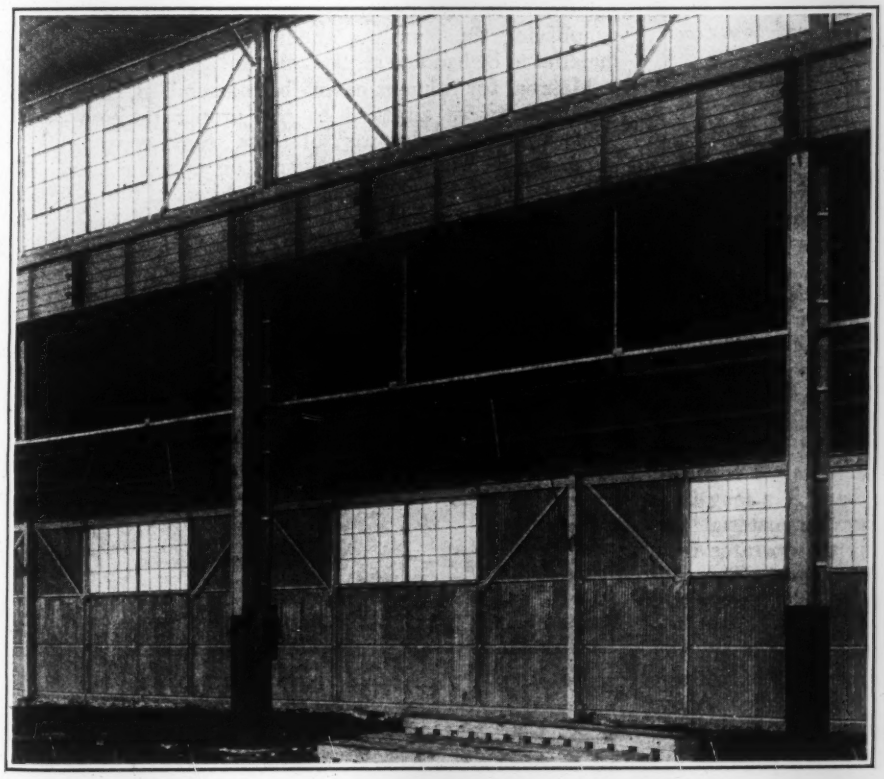

FIG. 3—WELDED FRAMING OF SHOP BUILDING
Welded columns built up of plates and shapes carry welded craneway girders and roof trusses. Note diagonal bars welded to webs and flanges of columns.

As there is no cross-connection at the top, these columns must have a heavier anchorage than the shop columns. For this purpose short pieces of channels are welded across both faces of the column, at the bottom, and the anchor bolts extend up through the flanges of these channels. For lateral support also an inclined brace is riveted to the outside of the column at the level of the craneway and extends to an anchor block. When a roof is placed, connecting the columns into a single structure, these wind braces may be removed.

Welding Machine—The economy and advantages of an automatic machine for extensive work in welding structural steel members had been realized for some time by G. A. Caldwell, general superintendent of the company. With welded construction adopted for the new plant, an oppor-

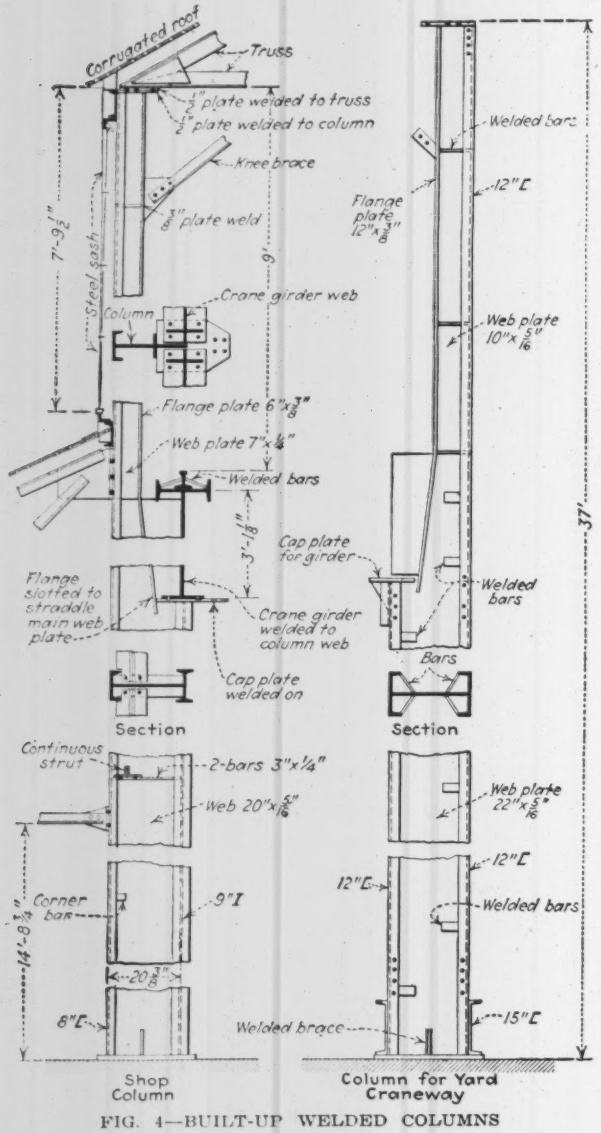

FIG. 4—BUILT-UP WELDED COLUMNS

tunity was afforded for experimenting with this development, since both design and fabrication of the structural material were under his control. A machine designed by him was built therefore at the company's plant at Decatur, Ill., where the material for the Melrose Park plant was fabricated. Fundamental claims for a patent for this machine have been granted, and Mr. Caldwell has applied for patents covering the principal features.

In this machine, shown by Figs. 7 and 8, a long table supports power-driven rolls carrying the material forward at a speed that can be varied by the operator from 2 in. to 40 ft. per minute, to suit the work. The rolls are reversible, so that material can be fed from either end of the table.

Near the middle of the table and above it are two sets of guide rolls, which hold the members or parts in proper position while the welds are being made. Above the work is a hold-down roller moving in guides and applying pressure to insure close contact between the pieces that are being welded together. All these rolls are adjustable, so that the machine can handle a large variety of shapes and sizes.

On each side of the table and near the middle of its length are two automatic welding heads, which are adjustable vertically, laterally and longitudinally to accommodate the various sizes and different methods of welding. Each head is wired to its own control panel and is also wired in step with the driving mechanism of the feed table.

This latter arrangement simplifies the control, as the closing of one electric switch is sufficient to change the operation from continuous welding to automatic stitch welding, the stitch or intermittent welds being of uniform length and spacing. Any desired length of stitch may be welded and the spacing may range from $3\frac{1}{8}$ to 27 in. Stitch welding includes the following series of steps, all automatic: (1) Cutting off the arc; (2) speeding up the travel of the material to the next weld; (3) slowing down this travel to a speed at which welding can be done; (4) striking the arc; (5) making the weld or stitch of prescribed length.

Two men operate the machine, one acting as a helper in placing the material and watching the second arc. In welding both columns and girders, the flanges were held to a tight bearing against the webs, and it was found that this was an essential factor in making good welds.

Welding Built-Up Columns—This work may be described as an illustration of the methods employed in machine welding. In preparing the material, the main and extension web plates and the flange plates for the extension webs were sheared to length, and the flange plates were slotted, as described. The I-beams and channels for the columns were cut and milled to length and punched on a spacing punch for field connections. These several parts were then stacked conveniently near the machine. All field connection holes, except those for details, were made in the webs of the channels, thus simplifying the punching and reducing the amount of material to be handled at the punches.

Material for columns having been assembled, the welding heads were adjusted to the proper position and angle. As the major part of these seams consisted of stitch welds 9 in. apart, staggered on opposite sides of the web, the electrodes were spaced $4\frac{1}{2}$ in. c. to c. longitudinally. The speed of travel was adjusted to $7\frac{1}{4}$ in. per minute while welding and 40 ft. per minute in shifting to the next weld. The first operation was welding the flange plates to the small or extension webs, forming

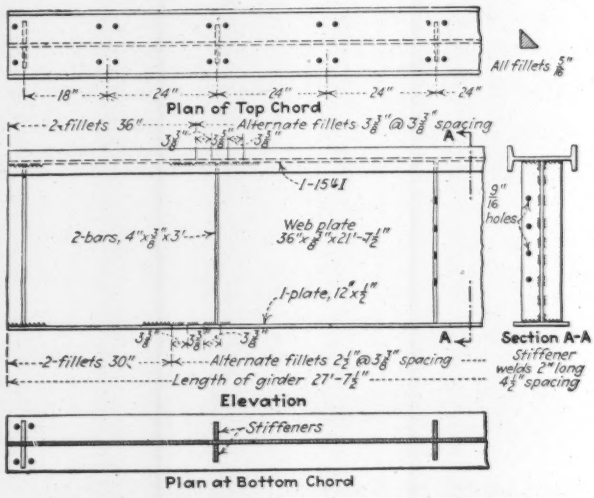

FIG. 5—WELDED GIRDER FOR CRANE RUNWAY

T-sections. These parts were laid aside and the I-beam inner flanges were welded to the main web plates and stacked ready for use.

For welding the channel forming the outer flange on the entire length of both main and extension webs and thus completing the column, the operations were as described below from a statement prepared by Mr. Caldwell. This description will be understood by referring to Figs. 7 and 8, although these represent the welding of a box column and a plate girder, respectively.

The channel for the column was placed on the table rolls, with its flanges upward and its bottom end toward the welding head. The main web, with the shorter I-beam flange already attached, was then placed with its edge resting on the center line of the channel, and the assembled parts were advanced through the guide rolls to the first electrode. There the channel rested on the middle roll of the table, a little higher than the others, and the hold-down roller was lowered to put the pieces under pressure.

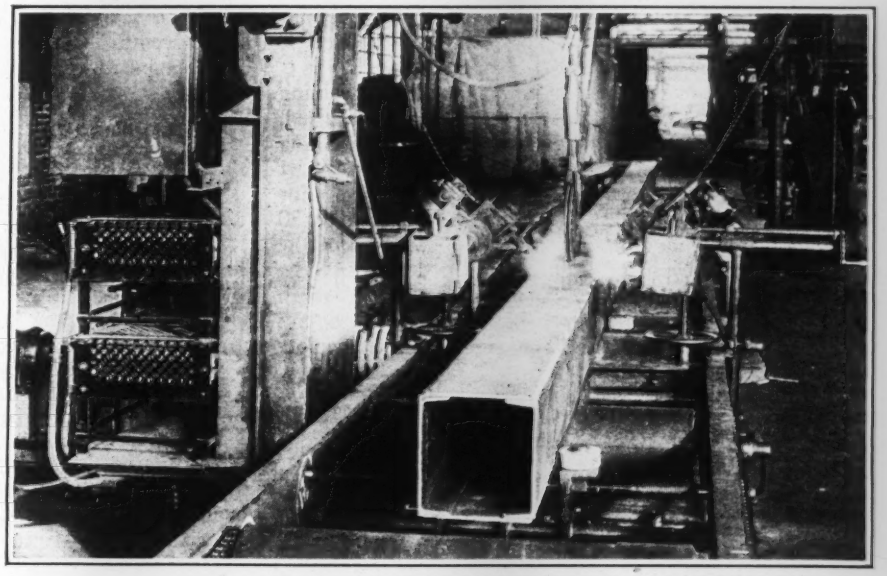

FIG. 7—AUTOMATIC WELDING MACHINE FOR STRUCTURAL STEEL

Box column on driven feed rollers, with guide rollers at side and top roller holding down cover plate. Welding head on each side of column. Note long end welds followed by intermittent stitch weld.

With the work in this position, the operator closed two switches controlling the travel and the first electrode respectively. This electrode then struck its arc and continued to weld as the material advanced. When the column reached the second electrode, the operator closed its switch and it also began welding, so that two seams were being welded, on opposite sides of the web plate and 4½ in. apart. This continued until the length for continuous welding was completed. Then the operator closed a fourth switch, and stitch welding proceeded until a point was reached near the end of the web, where a continuous weld was desired on account of the load from the crane girder. For this, the operator opened the fourth switch, and continuous welding proceeded until the end of the plate reached the first electrode.

Welding was then stopped, while one of the T-sections already welded to form the extension top of the column was placed in position, the continuous welding being then continued, attaching the web of this extension to the web of the channel. This completed the machine work, and the column was removed to have the details welded on by hand.

These details included the base plate, cap plate on top, cap plate on inner flange to carry the craneway girder, a bar on the inner flange as a connection to a kneebrace on the roof truss, and the crossbars from web to edges of the channels and I-beams. The craneway cap plate was let into the web of the column by notching the latter with a torch, the notch being afterward closed by welding the web plate to the cap. The forked end of the inner flange plate of the extension top of the column was bent over and welded to this cap plate and stitch welded to the main web plate. The abutting ends of the main and extension web plates were also welded together to form a continuous web.

Welding Crane Girders—Each plate girder had the bottom flange plate cut ¼ in. short at the ends, to clear the fillet made on the cap plate in welding this plate into the notch of the column web, as already described. As shown by Fig. 5, four holes were punched in each end of this flange plate for connections to the cap plate, and

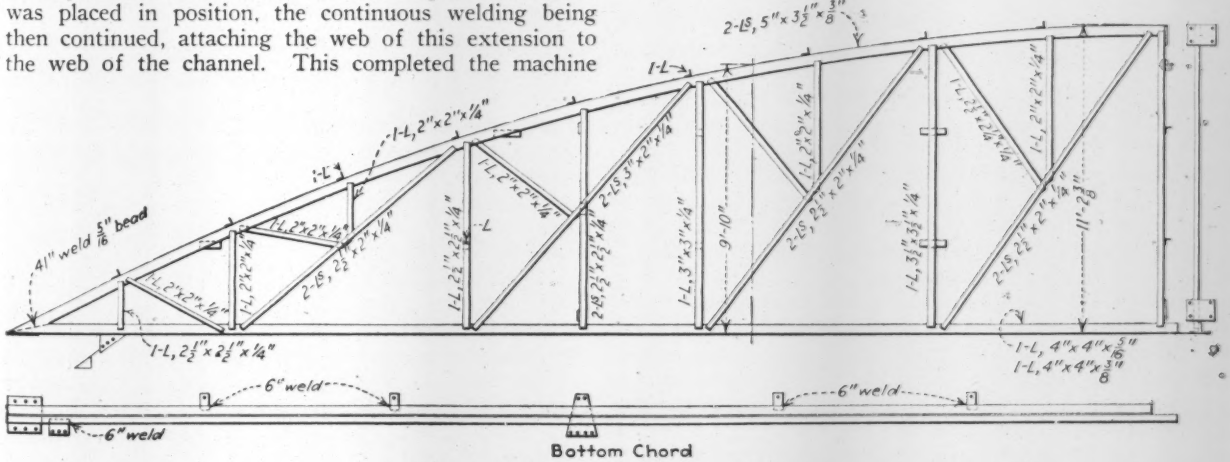
2-L's, 5" x 3½" x ⅜"
1-L
1-L, 2" x 2" x ¼"
41" weld 5/16" bead
1-L, 2" x 2" x ¼"
1-L, 2½" x 2½" x ¼"
2-L's, 2½" x 2" x ¼"
1-L, 2½" x 2½" x ¼"
2-L's, 2½" x 2½" x ¼"
1-L, 3" x 3" x ¼"
9'-10"
2-L's, 2½" x 2" x ¼"
1-L, 3½" x 3½" x ¼"
2-L's, 2½" x 2" x ¼"
11'-2⅜"
1-L, 2½" x 2½" x ¼"
1-L, 4" x 4" x 5/16"
1-L, 4" x 4" x ⅜"
6" weld
6" weld
6" weld
Bottom Chord

FIG. 6—DETAIL OF WELDED ROOF TRUSS

four holes in the top flange for the rail clamps. Holes were punched also in the stiffener plates for the electric wiring of the crane.

Welding the girders was less complicated than welding the columns, since only two double seams were required, attaching the chords to the web. The speed for welding was reduced to $5\frac{3}{4}$ in. per minute, while the speed of travel between welds remained at 40 ft. per minute. For the lower chord, there was a continuous double seam 30 in. long at each end and $6\frac{3}{4}$ in. apart on both sides of the web, but staggered in position. For the top chord, the continuous end welds were 36 in. long and the stitch welds $3\frac{3}{8}$ in. long, these latter being practically equivalent to continuous welds. The end and intermediate

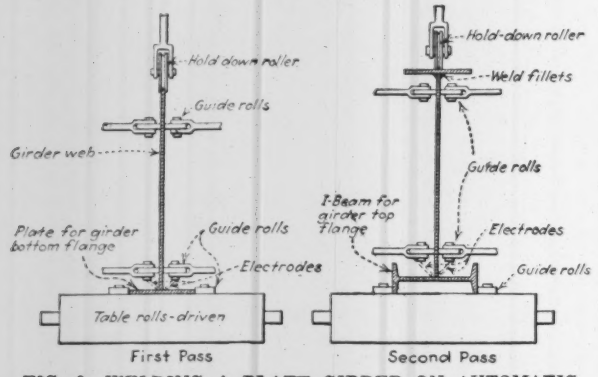

FIG. 8—WELDING A PLATE GIRDER ON AUTOMATIC MACHINE

At left, first pass through machine to weld web plate to plate for bottom flange. At right, second pass, to weld web to I-beam for top flange of girder.

stiffeners, $5\text{x}\frac{1}{2}$ in. and $4\text{x}\frac{3}{8}$ in. respectively, milled to a driving fit, were stitch welded by hand, completing the girder.

Tests of Girders—Coupons tacked at the ends of the seams of one girder were welded on by the machine as the work proceeded. When knocked off and pulled in a testing machine, they showed values of 7,600 to 9,400 lb. per linear inch of weld. Under a test load of 58 tons distributed over a length of 6 ft. at the middle, the girder showed no signs of failure in the welds. The deflection was $\frac{5}{16}$ in. and the stress in the bottom chord about 26,000 lb. per sq.in.

No warping or distortion was noticeable, except that where two continuous welds were made at the ends of the bottom chords the flange plates were slightly troughed. This effect appeared to a less degree at the ends of columns, where two continuous seams were made.

Designers—The layout of the new plant and the structural designs of the buildings were done by the company's staff; the material was fabricated at the company's shops at Decatur, Ill., and was erected by its own field forces. All this work was under the direction of W. M. Wood, president of the Mississippi Valley Structural Steel Company; G. A. Caldwell, vice-president and general superintendent (who also invented the welding machine), and R. D. Wood, general manager.

As to the results of this work, Mr. Caldwell has made the following statement:

"From the rate of travel and the welding speed the time consumed in making a welded seam can be figured, and this time will correspond closely to the observed time or number of these seams. Costs also can be figured, and it will be apparent that there is some saving over riveted work. This also checks with our cost sheets on this job. Altogether, it was a very satisfactory adventure, and we have been widely complimented on the appearance of the work."

Cross-Connections: Health Hazard Versus Fire Hazard

By Charles W. Sherman
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Conclusions of a paper read before the New York Section, American Water Works Association. The body of the paper was in large part a summary of the report of the cross-connections committee of the New England Water Works Association, which, together with the discussion at one of the winter meetings of the organization, was abstracted in *Engineering News-Record*, March 22, 1928, p. 488.

Experience to date indicates that double-check valves of the latest improved type, such as specified by the Associated Factory Mutual Fire Insurance Companies, provide as complete protection as any mechanical contrivance can furnish against pollution of potable water supplies through cross-connections. If such devices are properly installed, inspected and maintained, the danger of contamination through cross-connections so protected is very slight. In fact, the danger of pollution from such a source appears to be less than that due to possible failure of disinfection, where dependence is placed upon a single chlorinator. The danger still exists, however, and because it may be less than some other dangers is no reason for permitting its continuance.

On the other hand, the possibility still exists that a double-check valve may fail to act, and even monthly inspection cannot give absolute assurance that the apparatus will function perfectly at all times. Moreover, if such an apparatus does fail, the result may prove disastrous.

Therefore, even though the hazard of cross-connections, protected by Factory Mutual double-check valves, may be less than that from other sources with which water-works superintendents have to reckon, the use of cross-connections should not be continued, if it can be avoided. The danger, however, from cross-connections which are protected by double-check valves, properly constructed and maintained, does not appear to be sufficiently serious to necessitate extremely drastic measures for their complete abolition. I mean by this, that where the best modern appliances are installed, a requirement that they be eliminated forthwith or on six months' notice would not be justified.

The sensible course appears to be to recognize that cross-connections are always undesirable and that their complete elimination should be the ultimate goal; that no new connections should be allowed even with the best protection possible; that existing cross-connections may in some cases be continued for a time, if Factory Mutual double-check valves are properly installed and maintained, but that after a time even these connections should be eliminated.

It is probable that the procedure adopted in New York State of setting a date for the removal of all such connections is the wisest course to adopt. In some places and under some conditions, as where the original notice was short or where there may be great difficulty in separating the pipes without introducing greater dangers than would be eliminated, it may be expedient to extend the time for total elimination, but the object should be to attain that condition as soon as is reasonably possible.

MODERN CEMENTS

A Study of the Characteristics of the Hydraulic Cements of Today

In Two Parts { **Part I—White Cement, Waterproofed and Masonry Cements**
Part II—High-Early-Strength Cements and Standard Portlands

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U. S. Bureau of Standards, Washington, D. C.

INTRODUCTION — The portland cement industry in the United States is a development from the natural cement industry.

Making natural cement differed but little, essentially, from lime making. Lumps of an impure limestone, containing particularly silica and alumina, were burned in limekilns to a temperature that brought about a certain amount of chemical combination of the elements but did not produce a hard, clinker-like mass. The burned stone was then ground, and a quick-setting but slow-hardening, fat-mortar-making cement resulted. The very nature of the process of manufacture indicates that the product was subject to wide variations in quality. To overcome this the stone was later sorted and like lots of material were ground, briquetted with a binder and burned in a stack kiln. If such burning were carried sufficiently high, some true clinker, approaching that of portland cement, was obtained.

This mixture of hard-burned clinker and soft-burned clinker, on grinding, gave a product partaking sometimes more of the nature of natural cement and sometimes more of the nature of portland. But the labor costs of briquetting, feeding the kilns, etc., led finally to experimentation which resulted in the development of the rotary kiln, with the consequent appearance on the market of true portland cement. This, retarded with gypsum, produced, when compared with the old natural cement, a relatively slow-setting but quick-hardening cement.

At the present time in this country portland cement finds itself in the same position relative to a new product—high-early-strength cement—that natural cement occupied about a generation ago relative to portland cement. Natural cement was made by a simple process requiring but little control and giving a slow-hardening commodity; it found itself being displaced by a new product, portland cement, made by a far more complex process and requiring much greater control but yielding a far more rapidly hardening cement. Today the high-early-strength cements are rising up as competitors of portland cement, and again require a more complex method and far greater attention to control details, but give results which users appear to desire. Is the history of portland cement to be repeated in the development of the new high-early-strength cement?

This paper is written to throw some light on the present status of production and use of standard portland cement as well as the various other hydraulic cements now commercially available. The latter, which include other types besides the much-discussed high-early-strength cements, are gradually but surely gaining a foothold in the producing and consuming industry. To what extent the new cements will replace the old is difficult to say.

PART I

White, Waterproofed and Masonry Cements

WHEN portland cement appeared on the market, it at first very gradually but later very rapidly replaced natural cement. It had the appealing quality of being so much more quick-hardening that its deficiency in such qualities as workability, a quality which was so marked in the natural cements, was not noticed. As time went on and cement was used for new purposes, as in concrete subjected to the action of sulphate solutions, it was noted that concretes of portland cement were too frequently not giving the desired satisfaction. Concretes used for securing water-tight structures were often found lacking. Also, though the gray color of portland cement was acceptable for most uses, there was a good demand growing for white cement. Finally, although standard portland cement was quick-hardening as compared with its chief predecessor, it is still sufficiently slow-hardening that it will not produce a safely usable structure before the expiration of one or more weeks after making.

New Cements in Europe—We are inclined to think of Europe as being conservative in many of its tendencies, but so far as the use of cement is concerned it must ever be thought of as radical. Not only was it the birthplace of portland cement but the use of reinforced concrete also had its inception there—two distinct evidences of a lack of regard for established conservative institutions. This radicalism has not ceased, and the making and using of different varieties of hydraulic cements have gone on apace. In a recent issue of *Beton-Strasse* the North German Cement Combine (combines of industries are permissible under certain legal regulations in Germany) advertises the following cements: Portland, Eisen-Portland, Hochofen and Hochwertige. In the same issue the South German Combine, apparently throwing all restraint aside, advertises: Portland, Eisen-Portland, Hochofen, Prima, Roman, Hochwertige, Montan and Trass-Portland. The exact nature of some of these is not generally known. "Eisen-Portland" cement, however, is 35 per cent blast-furnace slag ground with 65 per cent portland cement clinker. "Hochofen" cement is 65 per cent blast-furnace slag ground with 35 per cent clinker. "Hochwertige," erroneously translated very frequently as super cement, is high-early-strength portland cement. "Trass-Portland" cement is a mixture of trass, a volcanic ash, with portland cement.

It should be noted that these advertisements are made not by individual manufacturers but by the association of the cement manufacturers in that particular portion of Germany. The same condition exists in France, although there is no unified action by the manufacturers. The sit-

uation there is still more striking in that according to the national specifications portland cements themselves are grouped into various classes, depending upon the time of set and strength developed in testing the cement.

American Developments—But it must be confessed that while in this country no group will more than tacitly confess the manufacture of many kinds of cements, there are actually now purchasable here the following types in addition to standard portland: Natural cement, slag cement, plastic masonry cement, high-alumina cement, high-early-strength portland cement, "super" cement, white portland cement, waterproofed white cement and waterproofed gray cement.

Five Groups—Essentially these varieties can be placed in five groups: Two minor groups, (1) the white portland cements and (2) the waterproofed cements; and three major ones, (3) the plastic, or masonry, cements (4) high-early-strength cements, and (5) standard portland cements. In this classification the natural, plastic and slag cements fall into the plastic or masonry group. "Super" cement (a special cement made by a number of organizations under the patents of the Super Cement Company, consisting of ordinary cement clinker ground with a plaster to which has been added a very small per centage of tannic acid, "catacoll"; it is *not* a high-early-strength cement) may be placed in this same group or in the waterproofed group, since it is sold as fulfilling both demands. The high-early-strength cements, which also are very plastic, might themselves be considered in the masonry group were they not set apart by their more prominent characteristic. Any cement to which a waterproofing agent has been directly added and which is sold in this condition would be classified as a waterproofed cement. The high-alumina cements are placed in the high-early-strength group.

Although at the present time the public is particularly interested in the major groups, a few remarks will be made regarding the other two.

1—White Cement

WHITE cement is in competition with gray cement only when white mortar in the setting of masonry or the making of stucco is desired. It is also used in the casting of concrete products when a white bond is desirable. It is a true portland cement, containing less than ½ per cent iron oxide, and as such it should meet the present for (gray) portland cement.

Its Erroneous Basis—It was originally produced to meet a demand created by an entirely erroneous idea. Certain building stones were found to become stained a light brown to almost black after being set or used in contact with portland cement mortar. It was assumed, quite incorrectly, that this stain was due to the leaching of iron oxide from the cement by the weathering agencies and that if a cement containing but very little iron oxide were used the stain would be slight or not noticeable. Consequently the white cements were made and marketed.

Real Chemistry—Had this matter been correctly thought out, it would have been seen immediately that the iron oxide of the cement would not go into solution in water until practically all the lime of the cement had first been leached out. By the time the latter had occurred

TABLE I—ANALYSES AND TESTS OF PLASTIC MASONRY CEMENTS

		1	2	3	4	5	6	7 (g)	8	9
Cement Nos.										
Fineness, per cent residue on No. 200 sieve		29.4	7.5	19.0	13.8	19.8	34.3	10.9	5.5	6.5
Time of set (Gillmore), hours : minutes	Initial	5:30	(d)	3:05	0:35	1:10	4:15	(d)	6:05	4:45
	Final	(d)	(d)	4:55	1:40	2:25	(d)	(d)	7:35	7:25
Soundness	Steam, 5 hours	OK	OK	OK	Chalky and broken	OK	Disintegrated	Soft	Chalky and warped	OK
	Air, 3 months	OK	OK (b)	OK (b)	OK (b)	OK	OK	OK	OK	OK
	Water, 3 months	OK	OK	OK	OK	OK	OK	OK	OK	OK
Strength, pounds per square inch:										
Neat cement tests—water storage (after 24 hours):										
Mixing water (water per cent of dry material by weight)		39.0	29.2	34.0	34.0	32.2	29.2	48.0	34.3	30.0
1-in. briquets (tension)	7 day	97	178	173	134	177	69	66	104	317
	28 day	191	268	249	188	308	127	111	221	473
	1 year	347	366	319	372	519	473	167	358	625
2-in. cubes (compression)	7 day	485	915	965	710	1,500	480	330	600	3,580
	28 day	1,305	1,630	1,845	1,445	3,325	775	720	1,230	5,690
	1 year	3,090	2,560	3,770	4,955	6,000	5,135	1,475	4,015	10,495
1:3 standard Ottawa sand mortar tests (parts by weight) —water storage (after 24 hours):										
Dry normal consistency (water per cent of dry material by weight)		13.7	11.4	12.4	12.2	11.9	11.6	14.5	12.2	11.0
1-in. briquets (tension)	7 day	34	80	66	51	62	(e)	42	38	189
	28 day	85	128	137	118	168	(e)	76	104	285
	1 year	141	254	121	215	211	179	87	294	402
2-in. cubes (compression) (air storage)	7 day	155	415	345	275	420	85	260	210	1,470
	28 day	475	630	805	705	990	145	490	495	2,295
	1 year	1,260	1,150	1,670	3,055	2,265	1,420	790	1,810	5,040
Brick-laying consistency (water per cent of dry material by weight)		17.3	13.5	16.1	15.3	15.4	15.5	19.7	14.5	13.7
1-in. briquets (tension)	7 day	44	(e)	37	33	37	14	22	22	125
	28 day	38	16	39	45	40	13	42	21	159
	1 year	36	14	38	42	32	30	64	51	205
2-in. cubes (compression)	7 day	200	180	260	260	235	125	225	270	910
	28 day	230	205	350	325	270	125	315	390	1,180
	1 year	225	130	365	350	315	145	410	425	1,705
Chemical analyses:										
SiO_2		20.85	34.27	24.07	21.34	19.00	23.81	8.22	20.35	26.45
Fe_2O_3		1.40	0.35	0.83	1.26	1.96	4.18	0.73	1.85	0.76
Mn_3O_4		0.14	0.36	0.03	0.29	0.09	0.68	0.03	0.07	0.02
P_2O_5		Trace	(h)	(h)	(h)	(h)	(h)	(h)	(h)	(h)
Al_2O_3		6.04	11.69	5.98	5.61	6.16	8.01	4.11	7.43	3.82
CaO		34.83	47.08	32.29	47.50	45.46	32.00	51.03	50.87	60.34
MgO		22.25	1.51	22.17	13.23	15.19	18.45	21.80	2.75	2.52
Na_2O		0.14	0.25	0.02	0.30	0.30	0.26	0.32	0.39	0.27
K_2O		1.60	0.91	2.66	0.57	1.36	0.44	0.02	1.00	0.18
SO_3		2.11	0.10	1.74	1.87	1.03	2.53	1.15	1.43	0.55
CO_2		(f)	(f)	7.97	(f)	7.00	7.15	1.70	(f)	(f)
S (present as sulphide)		....	1.02	....	....	....	....	....	....	....
Combined H_2O and organic material, by difference (c)		10.64	2.46	10.21	8.03	9.45	9.64	12.59	13.86	5.09
Ignition loss (a)		11.12	1.79	10.10	8.00	9.47	8.26	12.96	13.41	5.43
Insoluble residue		11.88	0.27	14.62	4.04	5.51	13.65	0.88	6.32	4.16
Insoluble soap (approximate figure)		....	....	....	1.20	....	....	....	....	....

(a) Total ignition loss at temperature of blast. Determination subject to error. (See Hillebrand, U. S. G. S. Bulletin 750, and Mellor's "Quantitative Organic Analysis.") (b) Shrinkage cracks across pat. (c) Includes any CO_2 present. (d) Not determined—exceeds seven hours. (e) Specimens too weak for satisfactory tests. (f) CO_2 present, but quantity not determined. (g) As received contained hair which was removed by sifting prior to tests. (h) Not detected.

the mortar would have failed completely and would remain as a mass of practically unbonded sand grains. Furthermore, it took but a meager amount of investigation to show that the staining material is present in the stone alone, but that it apparently becomes soluble in the presence of the solutions of the decomposed compounds of sodium and potassium oxide of the original cement. The compounds of either of these may be present at certain times in sufficient amounts in either white or gray cements to permit, in the presence of precipitation of moisture from the atmosphere, of their dissolving the staining material of organic origin in the stone. This, in the absence of further precipitation, comes to the surface through capillarity and leaves the brown strain on evaporation.

Service Test Necessary—As practically all naturally occurring raw materials used in making either white or gray cement may contain these two alkali compounds, the finished cements are also likely to contain them. But it is apparently not the *amount of these oxides* in the finished cement which will cause the solution of the staining material in the stone, but rather the amount of a certain readily decomposed compound of the oxides. Therefore the only assurance of absence of stain-inducing proclivities on the part of a cement is by actual test.

The test can be readily carried out on a block of stone known to contain the organic matter. The presence of organic matter may be determined by allowing a piece of the stone to project 3 to 5 in. above a 2 per cent solution of sodium carbonate (washing soda or soda ash); the solution in rising to the top of the stone through capillarity will bring the stain to the surface if it is present. In a suitable sample of such stone a hole should be bored and lined with a mortar of the cement in question. After the latter has set, the cement-lined hole should be filled with water and this allowed to seep through the mortar and the stone. In the course of several days the stain will appear on the stone if the cement has any tendency to induce solution of the organic matter.

Action of White Cement—When white cement is used for its color and not as a non-staining cement, it should be tested and used as a standard portland cement. It is made from the same raw materials as the latter, selected, however, for their very low iron oxide content, and is made by a similar process. Normally the low iron oxide content would make a quick-setting cement, but this effect is overcome by the use of a higher silica content and slightly lower lime content. The result is a cement which hardens at a slightly slower rate than standard gray portland.

2—Waterproofed Cements

THE waterproofed cements have come on the market as a result of the demand for a waterproof or water-repellent concrete or mortar. It was believed that an agent filling this demand could be ground directly with the cement and consequently it would not be necessary to add an integral waterproofing admixture during the mixing of the concrete batch.

Waterproofing Means—Generally these waterproofed cements are standard portland cements which have been ground with soaps of stearic acid. A non-saponifiable oil is also being ground with clinker for the same purpose. The proprietary "super cement" containing "catacoll" is also claimed by its promoters to be more waterproof than cement prepared from the same clinker without this addition. Hydrated lime, diatomaceous earth and finely ground inert materials are also claimed to render concrete more dense and hence more impervious to water.

Their Action—There is no doubt that it is absolutely essential to prevent water from seeping through concrete. Otherwise the percolating water will dissolve from the concrete both hydrated and unhydrated cement, with a consequent weakening of the structure as well as an increase in the likelihood of damage due to the freezing and thawing of the entrained water. Whether concrete can be rendered satisfactorily impervious to water by the use of integral compounds added to the concrete mixes or to the cement in grinding is an unsettled question. Their use will not prevent the seepage of water through shrinkage cracks; for this purpose it would surely seem more logical to secure the essential and positive water-tightness by the use of a truly waterproof membrane applied to the surface of the finished concrete.

Resistance to Corrosion—If the penetration of water could be prevented, it would follow that the concrete would be immune from the attack of any salts which might be present in the water. Hence truly waterproof concrete would be salt proof and "alkali proof." "Super" cement is stated by some to be alkali proof. To date, however, cements developed particularly for resisting sulphate salt attacks have had this property produced more especially through a change in the nature of the cement, induced by change in composition. Thus, there are the Eisen-Portland, Hochofen and maritime limes of Europe, and the high-alumina cements.

In this country we have but little experience to prove whether this chemical resistance can be produced successfully by special composition, but we have many instances of enduring concrete made with normal cement. Unfortunately we have many also which are badly disintegrated but which, according to data from abroad, might have given indications of good life if they had been made of one of the resisting cements.

Prejudice here against the use of any but standard cements has not permitted of any major field trials of any other cements. Hence confirmatory field data in this country are lacking.

3—Plastic Cements

WE COME now to the first of the major group of the newer cements—plastic or masonry cement.

Integral Admixtures—The inability of portland cement to make a fat-working mortar or a workable concrete has resulted in the use of various admixtures to produce this desired quality. Until recently the most commonly used of such agents was hydrated lime added in the mixing of the mortar or the concrete. More recently a mixture of 60 per cent portland cement and 40 per cent by weight of hydrated lime has appeared on the market as a masonry cement. The use of diatomaceous earth in mortars and concretes has also led to the placing on the market of prepared mixtures of this and portland cement. There have also been available for longer periods mixtures of portland cement and what are essentially natural cements, also portland cement and such plasticizing agents as petroleum oil.

Natural and Slag Cements—Natural cement, known of old, is still available and is on the market almost entirely for masonry-setting purposes, due largely to its plastic or fat-working properties, which have always characterized it to a very marked degree. The same is true of slag cement, and, while this is now available from one source only, it has a wide distribution on account of

its excellent working qualities. "Super" cement is also claimed by its producers to be of a more plastic nature than untreated portland.

Difficulty of Test Evaluation—With the wide variety of plastic cements on the market the purchaser is indeed in a quandary as to which he should buy. There are no standard tests to determine their qualities, especially that of workability. Futhermore, there are no sound, well-developed service requirements upon which to base tests. The attempt to evaluate service quality by means of small laboratory tests of mortar would in the majority of cases be extremely disappointing, since there would result the inevitable comparison with similar tests of portland cement mortars. But plastic cements are produced solely as a result of a demand for smooth, easy working qualities, which are in no manner indicated by *strength* tests. Furthermore, if strength tests are desired, they should be based upon what the demands in a masonry structure would indicate. So far the controlling feature in this latter condition is represented by the requirements of our building codes covering allowable loads on brick, tile, walls, columns and the like. Using these as a basis, it is believed that many of the masonry cements now on the market would have ample strength.

Tests Necessary—Nevertheless, for the discriminating and intelligent use of these cements there should be developed tests for determining their qualities of workability, particularly when placed upon their absorptive bases, as brick, stone or plaster. There should then be determined for specification purposes the limits of the numerical values which they should have to be acceptable as being truly plastic cements. Another physical quality whose numerical values and limits must be determined is that of volume change. The mortars made from these cements must not show even appreciable shrinkage on aging; otherwise there would appear cracks in the vertical joints of masonry, through which water would pass during rainstorms. This is a serious defect of many structures now, and far more masonry structures have failed through lack of water-tightness than have failed through actual lack of load-carrying capacity.

Filling a Need—The present status, therefore, of the plastic cements is that they are being produced and used in increasingly large quantities and are filling a well-defined need, calling for properties that are lacking in portland cement mortars unless the latter contain certain admixtures. However, they are being used solely on the sales argument that they are more plastic and through the acceptance of this argument by many users, at first with more or less questioning. The fact that the consumer generally continues to purchase them indicates that he has learned by his first use that they do meet his needs. The outstanding want in connection with their use is solely lack of tests and specifications.

In Table I are given some of the usual test data secured in testing a few cements of this type. It is unfortunate that there are no available data covering workability and volume change, *which are far more essential than the data in the table.*

Cheyenne Spending $675,000 on Water-Works

Cheyenne, Wyo., is beginning water-works improvements, to cost $675,000, including construction of a dam, 10 miles of pipe line, installation of six filter units, and a 48-m.g. clear-water reservoir. This city has commission government, with P. R. Revis as city engineer.

Runoff Figures in Vermont Flood Reach High Values

Results of Measurements in the Winooski Valley Reveal Unprecedented Stream Flow Per Unit of Drainage Area

By H. B. Kinnison
District Engineer, U. S. Geological Survey, Boston, Mass.

IN NEW ENGLAND freshets of considerable magnitude occur rather regularly in the spring, but destructive floods so seldom that the possibility of a flood as great as that of November, 1927, had not been considered.

The ordinary spring freshet discharges 15 to 30 sec.-ft. to the square mile on small drainage areas; the maximum for a ten-year period has seldom reached more than 50 sec.-ft. to the square mile. For instance, the twelve-year record on the Westfield River near Westfield, Mass., shows a maximum discharge, in April, 1924, of 49 sec.-ft. to the square mile from an area of 496 square miles. Farther upstream, at Knightville, the maximum discharge in a period of eighteen years occurred at the same time and reached 65 sec.-ft. to the square mile from an area of 162 square miles. On the Pemigewasset River at Plymouth, N. H., over a period of 24 years, the maximum flow occurred in 1923, with a discharge of 46 sec.-ft. to the square mile from an area of 615 square miles. Over a period of fourteen years on the White River at West Hartford, Vt., the maximum flow of 44 sec.-ft. to the square mile from an area of 687 square miles occurred in 1913. The fifteen-year record on the Winooski River at Montpelier, Vt., where the drainage area is 420 square miles, indicates a maximum flow, in 1912, of 48 sec.-ft. to the square mile. On the Connecticut River at Sunderland, Mass., having a drainage area of 8,000 square miles, a record covering 23 years gives a maximum discharge of 17 sec.-ft. to the square mile in 1913.

In view of these records, it is not surprising that dam spillways and bridge openings were found woefully inadequate to pass the flood flow resulting from the great storm of last November, a flow that exceeded by many times any recorded discharge in this region. The failure may have been due in part to the old practice of building dams without the services of capable engineers. It is imperative that all dams built in the future be designed to pass safely flood flows as great as those which occurred in 1927. In general, the flood flows reached a maximum of well over 100 sec.-ft. to the square mile, and several determinations show 300 to 500 sec.-ft. to the square mile. It is doubtful if dam spillways had capacity to pass the flood anywhere in the flooded area, except where the flow was affected by storage.

Several stream-gaging stations were formerly maintained on the streams in Vermont by co-operation between the U. S. Geological Survey and the State of Vermont. Because of the withdrawal of the Vermont co-operation in 1923, these stations were not in use at the time of the flood. The Geological Survey, however, was operating nearly 60 stations elsewhere in New England at that time. Determination of the flood flow at these stations and special studies on nearly every affected stream in New England have made available flood-flow determinations at about 150 points.

Among these special studies several were made on the

Winooski River and its tributaries in Vermont. The highest flow determined in this drainage basin was on the Jail Branch of the Winooski River above East Barre. At this point the Geological Survey had formerly maintained a stream-gaging station at which a rating curve had been determined to medium stage. From a study of conditions at the control section it was evident that a logarithmic extension of the curve would probably be applicable at this station. Such an extension of the rating curve gave a discharge of 11,500 sec.-ft. from the drainage area of 38 square miles, or 303 sec.-ft. to the square mile.

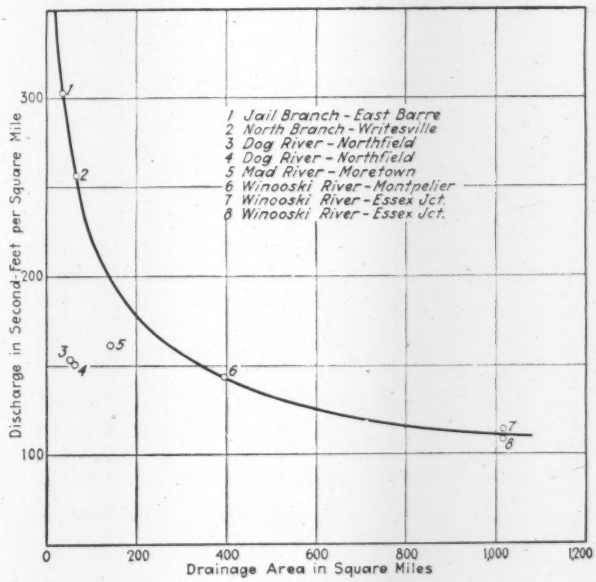
On the North (Worcester) Branch of the Winooski River the flow over the dam at Writesville, 4 miles above the mouth of the river, was determined to be 17,200 sec.-ft. from 67 square miles, or 257 sec.-ft. to the square mile.

On the Winooski River 1 mile below Montpelier, the rating curve for the abandoned stream-gaging station was extended to high water giving a discharge of 57,000 sec.-ft. from a net drainage area of 396 square miles, or 144 sec.-ft. to the square mile. In an attempt to check this figure, two slope studies were made. Because of poor conditions for accurate determination of discharge by this method, one result was greater and the other less than that obtained from the rating curve.

A gaging station had formerly been maintained on the Dog River at Northfield, Vt., with the rating curve developed to fairly high water. A logarithmic extension of the curve indicated a maximum discharge of 8,000 sec.-ft. from 52 square miles, or 154 sec.-ft. to the square mile. A determination of the maximum flow at the dam a mile below this point was made by computing the flow over the dam, which was 9,160 sec.-ft. from 60.5 square miles, or 151 sec.-ft. to the square mile.

The maximum flow in the Mad River below Moretown, Vt., 1¼ miles above the mouth of the river, was determined by computing the flow over a dam, the result being 23,000 sec.-ft. from 143 square miles, or 161 sec.-ft. to the square mile.

Near the lower end of the Winooski River two determinations of the maximum discharge were made. One was a determination of 110,000 sec.-ft. by a slope study over a fairly uniform section of river 2,340 ft. long, with a fall of 1.54 ft. about 4 miles above Essex Junction. The other determination was made at the dam at Essex Junction, where the maximum flow was computed to be 116,000 sec.-ft. As the net drainage area of 1,016 square miles was practically the same at both points, the discharge was 108 sec.-ft. to the square mile at the upper point and 114 sec.-ft. to the square mile over the dam.



AREA DISCHARGE CURVE, WINOOSKI RIVER, VERMONT, FOR FLOOD OF 1927

The accompanying illustration is a characteristic area-discharge curve for the Winooski River Basin for the flood of 1927. It indicates what could be expected in flood flow to the square mile for any area on the river.

The effect of the reservoir above the Mollys Falls dam, which controls about 24 square miles, is of interest in this connection. The reservoir did not start to discharge until several hours after the peak had passed in the river below. The maximum discharge reached was only 580 sec.-ft., or 24 sec.-ft. to the square mile.

Production and Efficiency in the Cement Industry

EXCERPTS from the address before the Portland Cement Association at its spring meeting at the Hotel Biltmore, New York City, May 21-23, by the president of the association, G. S. Brown, president, Alpha Portland Cement Company, Easton, Pa.

OUR industry continues to make records, 1927 showing a new record in consumption and production of portland cement, and, while the first four months of this year have been somewhat disappointing in that consumption has been less than for the same period in 1927, there seems to me to be every indication that we shall, as a whole, probably end the year without much if any loss, and perhaps with some small gain. Encouraging as this outlook is by comparison with many other industries, whose prospect is distinctly curtailed consumption, there is still with us the fact that we are working on a dangerously narrow profit margin.

Profits in the industry in the United States were generally less in 1926 than in 1925, and such statements as have been published for 1927 show still smaller returns than 1926. Were it not that the industry generally had during the last six or seven years used earnings with lavish hand in modernizing its plants and applied skillfully the knowledge gained through association statistics in reducing the use of coal and labor, we might be without any profits.

In the single item of labor there has been a reduction during the last six years of 19 per cent. The application of the heat formerly wasted from the kiln stacks to the production of power through waste heat boilers has reduced cost. Loss due to accidents has been greatly reduced.

Our engineers have been active in designing methods in quarry and mill to cheapen the cost of manufacture without reducing the quality of the product—in fact, all that has been done in the way of economy has been done despite the fact that quality as at present measured has materially improved. We have made a start in gathering statistics in regard to selling costs and in improving the work of our salesmen.

Whether the cement industry has kept pace with other industries in cost reduction we have no accurate means of knowing. Such data as we have would indicate that, generally speaking, it has done so.

Water Control in Excavating a Dam Foundation

Springs Developed in Seamy Rock Strata at Sharp Inclination—Local Drains Took Flow Outside of Forms—Flow Permanently Sealed by 2,000 Ft. of 5- and 6-In. Grout Holes

By W. W. Gruber
Assistant Engineer, Department of Forests and Waters, Harrisburg, Pa.

GROUTING and temporary drainage were required at the new dam for the Mount Union (Pa.) water supply, to an extent unusual in small dam construction. The dam is located some 6 miles south of the town in a mountain gap just below the junction of two streams draining about 3.8 square miles. It will form a 25,000,000-gal. reservoir.

Dam Structure—The dam, as completed to its present height, is shown by Fig. 1. A cross-section through the spillway is shown by Fig. 2; the flanking abutment sections are indicated in Fig. 1. The dam is of the hollow

FIG. 1—DAM FOR MOUNT UNION (PA.) WATER-WORKS
Dam built to about half of ultimate height; key ways in deck and buttresses provide for connection of additional structure when there is need for it.

type, of reinforced concrete, with a deck supported by buttresses 18 ft. on centers. It has a maximum height of 44 ft. and a crest length of 325 ft., composed of 198 ft. 7 in. of spillway, 18 ft. of abutment on the left and 72 ft. on the right—a total of sixteen bays—with a gravity section of 20 ft. at each end. The elevation of the foundation near the middle is 1,187; of the spillway crest, 1,231, and of the tops of abutments, 1,235. The structure is designed for future extensions, therefore the buttresses and deck slab are of sufficient thickness to resist the additional stresses and are so constructed that a few inches of the downstream face may be removed exposing reinforcing dowels (Fig. 2), which when bent forward will tie the present structure to the future extension. The buttresses vary in thickness from 21 to 14 in., and the deck slab from 41½ to 24 in. at different elevations.

The concrete mixture was designed for 2,000 lb. per sq.in. at 28 days. Cylinders tested at 28 days averaged 2,071 lb.

Foundation Rock and Refill—The overburden consisted of about 7 ft. of loose rock and clay, most of which was removed by steam shovel. Below this was hard ganister rock (siliceous-clay rock), with several interlaying strata of shale from 6 in. to 4 ft. thick and comprising about 20 per cent of the rock volume. The strata at the right end dip upstream about 3.5 ft. in 10 ft., and at the left end (Fig. 3) about 4.5 ft. in 10 ft., with about the same slopes from the ends toward the middle. Large horizontal and vertical seams, some open and others filled with clay, necessitated excavating below the depth originally anticipated.

It was not practicable to excavate a cutoff trench, as blasting loosened the entire stratum above the trench and caused it to slide toward the excavation. Excavation was carried down to reasonably tight rock for the upstream toe and to a suitable foundation material for the buttresses. This left the upstream wall of the excavation practically vertical and the downstream wall with a slope upward of about 20 to 25 deg.

A thin stratum of shale was encountered near the middle, which thickened toward the left until at buttress 17 (the left-end buttress) it was nearly 4 ft. thick. Due to the tendency of the shale to disintegrate when exposed and to its location with reference to the structure, it was removed to a point upstream where it was under about 2 ft. of solid rock, and then the V-shaped trench formed by the removal of the shale was filled with 1:3:6 concrete (Fig. 4).

Seepage Drains—The considerable flow into the excavation from the rock seams and crevices was handled by temporary drains. The usual method was to cover the crevices with inverted small tin troughs, and for small flow to strew fine crushed stone along the crevices to points where it could be dammed off with a few handfuls of clay. From these dams the water was conducted through pieces of old pipe or hose to suitable points in the forms, or to adjacent bays through conduits previously placed for that purpose, and thence to the downstream side of the forms. These drains (Fig. 5), including the clay dams and a foot or more of the pipe, were then covered with stiff cement mortar, which was allowed to set before placing concrete, thereby preventing leakage of grout into the drains when concreting. Frequently also the pipe was covered with mortar for a few inches

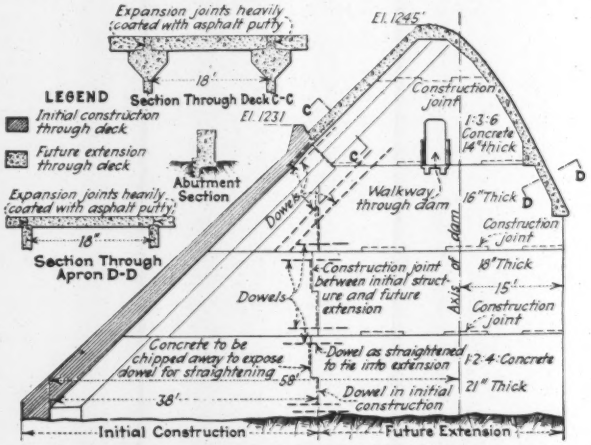


FIG. 2—SECTION THROUGH SPILLWAY WITH DECK AND APRON DETAILS
The notable features is the arrangement of buried dowels, which can be uncovered and bent into position to bond into added structure when the dam is heightened.

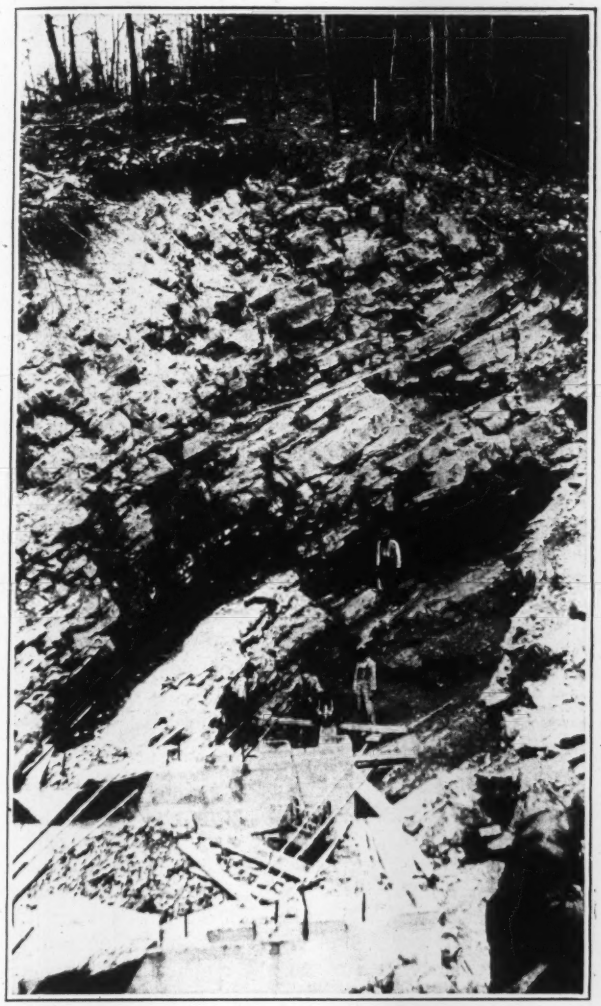


FIG. 3—ROCK ABUTMENT AT LEFT END OF DAM
Note the dip of the strata upstream across the dam. Men at bottom are digging out shale stratum afterward to be filled with 1 : 3 : 6 concrete.

at one or more points to prevent it from being moved and opening the clay dam.

Drilling Grout Holes—The plans provided for drilling grout holes at 4-ft. intervals throughout the length of the cutoff wall and 5-in. pipes were placed in the cutoff forms at the required intervals. These pipes were carefully set plumb and stiff mortar was poured around their bases the day previous to pouring the form.

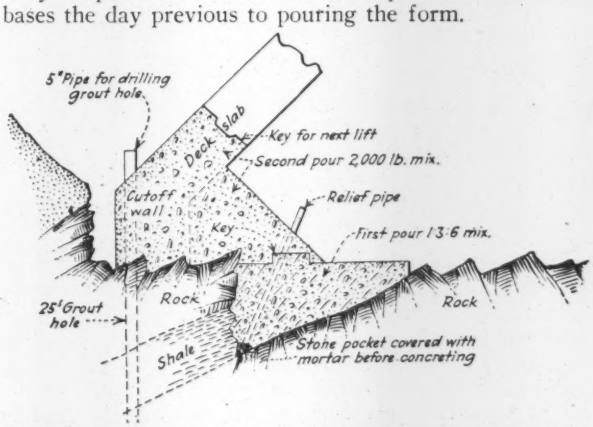


FIG. 4—DETAIL OF CONCRETE REFILL OF SHALE SEAM

Most of the work was done with a well drill, using a 4½-in. x 17¼-ft. stem, 4½-in. jars and 5-in. bits. Late in the season a drill, using a 4½-in. x 20-ft. stem, 4½-in. jar and 6-in. bits, was added. Drilling was commenced early in January, 1927, and by the middle of April about 35 consecutive holes, from the right end, had been completed. Thereafter alternate holes were drilled, as explained under the description of grouting. In all 62 holes were drilled; those on the right of the middle were 20 ft. deep and those on the left 25 ft. deep. Due to the 12-ft. lift in the foundation at buttress 17, three 8-ft. interval holes in the left gravity section were drilled 45 ft. deep, and at both ends beyond the dam several holes were drilled 70 ft. deep at 10-ft. intervals. The drilling record was as follows:

Number of holes drilled		70
Linear feet of drilling		1,783
Number of bits sharpened		742
Average per 100 ft.:	No. 1 Drill	No. 2 Drill
Actual drilling time, hr	131	60.1
Moving and delays, hr	40	30
Number of bits sharpened	50.4	20.5
Time sharpening bits, hr	63	25.6
Number of holes drilled	57	13
Linear feet drilled	1,263	520
Efficiency and conditions	Fair	Good

Grouting Procedure—Grouting was commenced after about 30 holes had been drilled. The outfit consisted of a 5x3x8-in. pump and two 80-gal. wooden mixing boxes. A blow-off valve and a steam gage was connected in the discharge line, and prior to commencing grouting the end

FIG. 5—TEMPORARY DRAINS FOR SPRINGS IN FOUNDATION BED
(1) Clay dam to divert water into pipe; (2) crushed rock for filling crevice at left; (3) crushed rock strewn along crevice; (4) crushed rock in place and covered with mortar; (A) mortar pillars to hold pipe from shifting when concrete is poured.

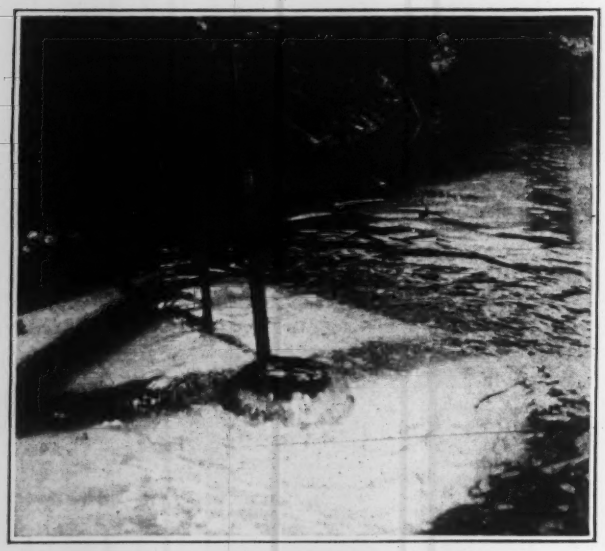


FIG. 6—SPRING FROM WELL DRILL HOLE SUNK FOR GROUTING FOUNDATIONS

of the discharge line was plugged, water was pumped through the line and the valve was set to the pressure desired, 40 lb., after which the gage was removed, the discharge connected to the hole and grouting commenced. In cases where considerable time was required to complete a hole, it was found that the blow-off valve would not work properly. When the pump was working under good pressure and the grout level in the mixing tank was apparently remaining stationary, the operator would release the set screw on the blow-off without disturbing the adjusting nut, and clear the valve of partly set cement. In case the valve did not overflow after it was cleared, a new piston was put in and pumping continued until the valve released under the pressure of pumping.

A mixture of two bags of cement to 30 gal. of water was used at the beginning of grouting a hole. This mixture was increased in density to three, four or more bags to 30 gal. of water after six or eight batches had been used or upon the appearance of heavy leakage. Ordinarily five-bag batches were found sufficiently dense to stop leakage, though in one case eight-bag batches were used and in two other instances it was necessary to use ten-bag batches. Eleven bags per batch was the most dense mixture used and is believed to be the limit for hand mixing.

On the right half, grouting was done in consecutive holes from the left. In a number of instances, when grouting a hole at this end of the dam, it was found that several adjacent holes were also filled by flowage through the rock crevices. Upon connecting to one of these adjacent holes it was found it took no more grout at the pressure (40 lb.) used. This was usually from six to ten hours after grouting commenced, allowing time for initial set. It is believed that these holes are not as completely grouted as those at the left end of the dam, where another method was used.

On the left half of the dam the 16-ft. interval holes were drilled and grouted immediately on the completion of drilling. Thereafter the 8-ft. interval holes were similarly treated and in a few cases those at the 4-ft. interval. It was found that the 16-ft. interval holes took from 81 to 173 bags of cement, except one on the left end, which took only 34 bags. The 8-ft. interval holes took from fifteen to 76 bags of cement, except two, which took eight bags. The few 4-ft. interval holes took from twelve to 32 bags. Hole 24 (numbering is from the right end) had not been drilled prior to grouting hole 25. When 25 was grouted, holes 23, 22, 21 and 20 were also filled through the rock crevices, which required 104 bags. Hole 24 was drilled later and took 32 bags without showing any signs of leakage.

The open condition of the rock under the cutoff was apparent from the fact that water from the downstream side flowed out of many of the grout pipes (Fig. 6) in the middle section of the dam when the upstream side of the pit was pumped out, and in several cases when grouting the 8-ft. interval holes, grout came out of pipes beyond adjacent grouted 16-ft. interval holes.

At first, when pumping grout, considerable difficulty was experienced with the rapid scoring of the pump pistons, which was later found to be due to large chips of steel in the cement. Thereafter the cement was passed through a sieve made from ordinary fly screen. By using a magnet 2½ oz. of steel chips were taken off the sieve from the refuse of 10 bbl. of cement and submitted to the manufacturer, who stated that they were from the steel-grinding media at the cement mill and through improper supervision had passed the various sieves. The grouting record was as follows:

Number of holes grouted	70
Average depth of hole, ft.	25
Total number bags cement	3,548
Average bags cement per hole in cutoff	36
Average bags cement per hole on ends	244
Ten-hour days pumping grout	24
Ten-hour days preparation, etc.	21

Summary of Grouting Experience—The writer's experience with this and previous grouting work would indicate that in all cases in order to fill the crevices as completely as possible it is advisable first to drill at an assumed interval, say 15 or 20 ft., depending on the size and number of crevices in the rock formation, then drill at half that interval, and if an appreciable amount of grout is consumed, to try at the quarter intervals, etc., until it is found that the crevices are completely filled. Drilling should not be carried on within 100 ft. of a hole which is being grouted or before the cement has its initial set. All holes should be grouted immediately after drilling so that the grout may not enter adjacent holes and close the openings leading from them.

Pumping water into the holes prior to grouting, in this case, gave no indication as to the amount of grout required, as the crevices in the rock were too large; in tighter rock formation this method could be employed to advantage.

The expansion joints between the deck slabs and buttresses permitted some seepage when the reservoir was filled; however, only three places were noted where the amount was so great as to cause dripping of water from the buttress haunches. This is not serious and probably will close up with sediment and deposit. On other structures copper strips have been placed across such joints while concreting, but the writer considers these unnecessary unless it is desirable to keep the downstream face perfectly dry.

Slight seepage also occurred at about 25 per cent of the points where form wires ran through the deck; these wires were run through eye nuts from which steel rods extended through the form. After pouring, the rods were screwed out and the holes (3 to 5 in. deep) in the deck were filled with grout. More careful work, or the use of an asphalt preparation, would no doubt entirely eliminate this slight seepage.

Sixth Report on St. Francis Dam Offers New Theories

Abutments Lifted by Landslide at Left Bank and Swelling Under Right—Cracks Permitted Underscour

IN A report on the St. Francis dam disaster just released, made for the Santa Clara Water Conservancy District by C. E. and E. L. Grunsky, engineers, and Dr. Bailey Willis, geologist, new views are advanced. For the first time in any of the reports stress is placed on two diagonal cracks through the structure, one near each abutment, which are believed to have occurred some months before the collapse. These cracks and their causes are cited as the forerunners of the "almost simultaneous" breaching of both ends of the dam. Opinions and data in this report which were not presented in the five other reports that have been abstracted previously (*Engineering News-Record,* April 5, p. 553; May 10, p. 733) are summarized below.

Findings of the Geologist—Dr. Willis says that the east abutment was located on a landslide.

It was an old slide which had become inactive and was modified by erosion and vegetation, but it is recognizable in the topographic forms of the hillside. When it had become soaked by the water in the reservoir standing against its lower portion, it became active and moved.

In summarizing his findings, he concludes from the geologic conditions that the abutments became saturated with water; that the water reached one or more fault planes back of the lower part of the east abutment, and it slid out by reason of its own weight; and that the east wing of the dam, left in the air, tilted the whole concrete structure toward the east, as shown by a ladder that was washed into the crack at the western base of the central monolith and is now pinched in it. The west wing, he holds, was swept out by the water rushing beneath as it was raised by the tilting.

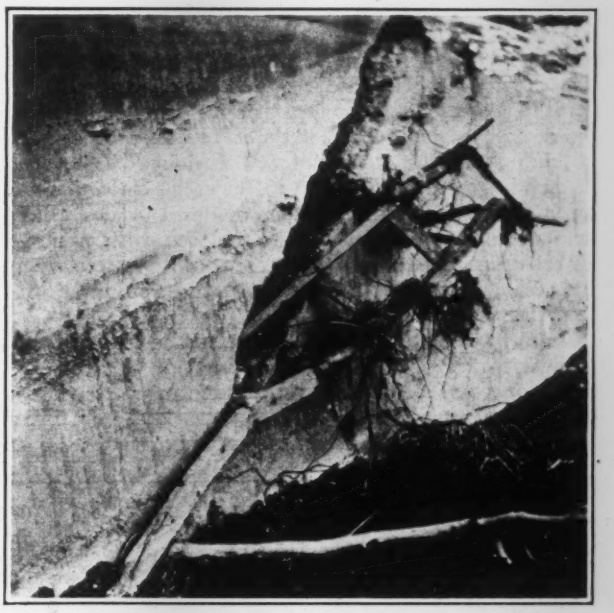
Findings of the Engineers—In the main portion of the report, prepared by C. E. Grunsky and concurred in by E. L. Grunsky, particular attention is given to the statement of V. M. Freeman, engineer, Santa Clara Water Conservancy District, that as early as last January there were two oblique cracks in the dam in fairly corresponding positions near the ends of the dam extending from its crest downward to the right and to the left, each at an angle of about 45 deg. The one near the east end reached the hillside about 65 ft. below the top of the dam. These cracks were widest at the bottom; the one near the east end can still be seen in the large fragment now lying in the streambed. They charge that these cracks were caused by vertical movement that occurred at some period earlier than January.

Swelling of the right bank, they say, would readily account for the upward movement of the dam at that end sufficiently to break it off. On the left bank the end of the dam was raised by the sliding pressure that thrust against it after water had penetrated the laminated strata of the schist and increased its mobility.

Discussing the effect of hydrostatic uplift on the dam, they say: "The dam was in distress at the initial stage of its failure not only because of the increased end pressure but also because at a full reservoir there was a great hydrostatic force under its foundation surface from end to end, relieved but slightly by a few weep holes." This hydrostatic pressure plus the forces due to the slide on one side and the swelling on the other broke the dam from its foundation.

"As soon as the dam was loosened on its base the toe of the structure spalled off. This was probably the beginning of its breaking up, and probably occurred at some time after 11:30 p.m. during the 28 minutes in which the water in the reservoir fell 0.3 ft. Thereupon, quite likely, a part of the east end of the dam, meanwhile undermined, went out and the dam at this end lost its hillside support. Hydrostatic uplift at the already loose west end and the weight of the remaining portion of the undermined east end caused a temporary tilting of the dam toward the east accompanied by a rapid washing away of the hillside under the dam at its west end, which then also began to break up."

A circumstance showing that the section remaining erect was raised from its foundation at its upstream face is seen by the position of a ladder found caught in a crack on the upstream face near the base. This crack



LADDER CRUSHED IN CRACK OF STANDING PORTION OF ST. FRANCIS DAM

The condition and position of this ladder are taken as evidence that the central (standing) portion of the dam tilted during the stress of failure and then settled back into place.

opened wide enough during the failure to allow the ladder to be sucked or thrust in sidewise, leaving about half of the ladder width protruding on the upstream face. The later closing of the crack as the standing section settled back to place crushed the side of the ladder that was in the crack in a manner that proves that it could not have been crowded into the crack as it now exists.

The engineers conclude that:

1. The site at which the dam was built was not a suitable site for a dam of the type that was there erected.
2. Neither solid gravity dams nor other types of dams which are rigid should be selected for localities where minor earth movements such as slides or swelling ground are probable.
3. The appearance as early as January, 1928, of cracks in the dam other than temperature cracks indicated a movement of the dam. Apparently the significance of these cracks was overlooked. A thorough study of the situation at that time should have disclosed most of the facts now known as to the unfavorable features of the dam site.
4. The failure of the St. Francis dam was due to the unsuitability of the foundation for the type of dam there built.

Springfield Water Distribution Aided by Service Facilities

Storage Yard, Service Building and Foremen's Houses Conveniently Located and Equipped for Efficient Service

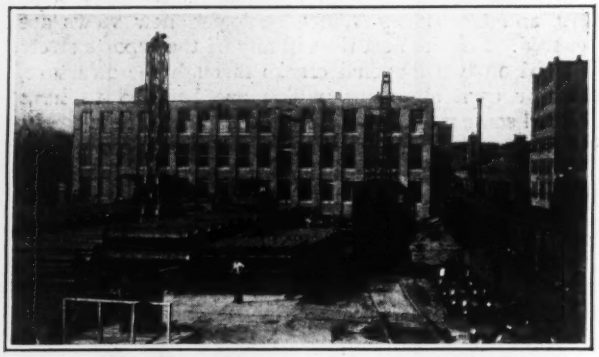
THE STORAGE YARD and service building of the water-works of Springfield, Mass., are well and favorably known throughout New England. They are here brought to wider attention, preparatory to a description of the operation of the distribution system which will appear in a later issue. —EDITOR.

CENTRALIZATION of supplies, administration, motor vehicle service, machine and meter shops at a well-located storage yard and service building, with housing on the grounds for foremen, has been a major factor in the efficient operation and maintenance of the distribution system of the water-works of Springfield, Mass. As the department lays all mains and services, sets valves, hydrants and meters and maintains all of these by its own forces, ample storage space and a good-sized service building are required. So compactly is everything arranged, however, that the yard and buildings are all located on a plot about 150 ft. wide at one end, 175 ft. at the other and 360 ft. long. The yard and buildings are well located to serve the entire distribution system, with level reaches or down grades to all parts of the city. The plot is inclosed with a non-climbable ornamental iron fence, set on a concrete wall, thus adding considerably to the attractive appearance of the property.

Most of the material stored in the yard comes in over a railway spur. Heavy material is unloaded by an electrically operated locomotive crane, mounted on standard-gage railway trucks, which run on a track laid on three sides of the yard, with turntables at the corners. The crane has a capacity of 1½ tons at a swing of 50 ft. Current is supplied through cable stretched from a 50-ft. tower located at the center of the yard.

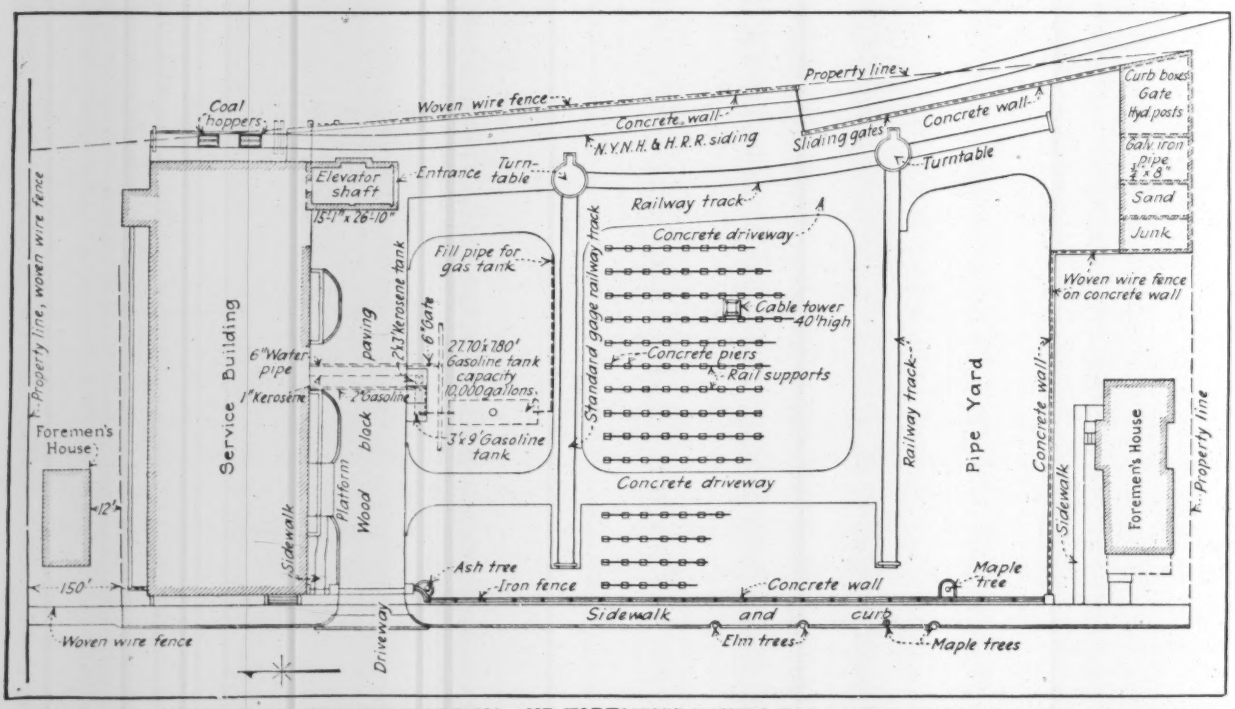
Cast-iron pipe, from 4 in. up, is stacked by sizes. The lower pipe lengths rest on steel rails, about 8 ft. apart, supported at ground level on concrete piers 6 ft. apart. Old fire hose fastened to the rail heads forms a cushion for the lower pipe.

A one-story shed, open on one side, houses smaller supplies. The shed is divided into sections, for curb boxes, gate boxes, hydrant posts, galvanized wrought-iron pipe, scrap metal and sand.

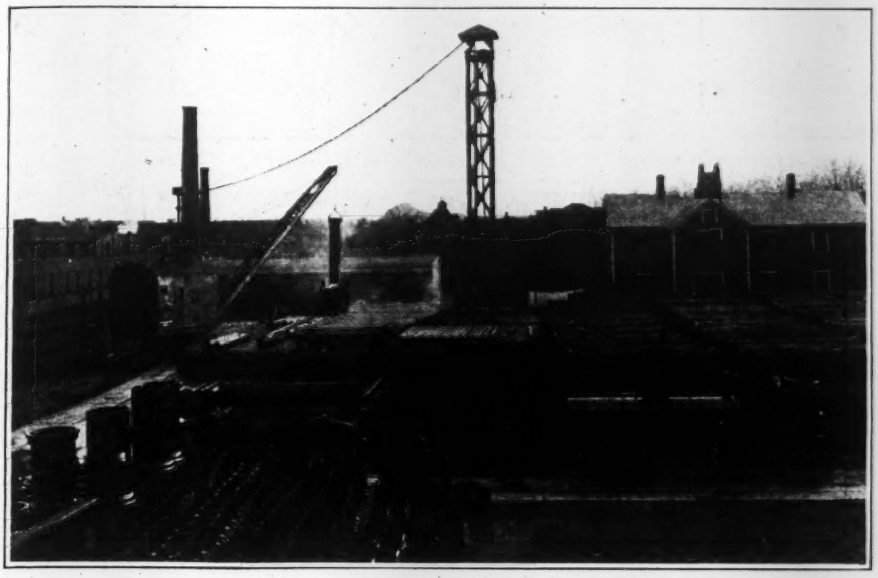


LOOKING TOWARD WATER-WORKS SERVICE BUILDING
Locomotive crane supplied with current from central tower stacks pipe in storage yard.

The service building extends crosswise of the yard, and is 50 ft. deep, nearly 140 ft. long and three stories high. Besides affording office space, it houses the department motor vehicles, repair shop for them, a machine shop, meter-testing and repair apparatus, brass goods and other small supplies. It is equipped with freight and automobile elevators. Two two-family, two-story foremen's houses located one at either end of the property,



LAYOUT OF STORAGE YARD, SERVICE BUILDING AND FOREMEN'S HOUSES FOR WATER-WORKS OF SPRINGFIELD, MASS.



SPRINGFIELD WATER-WORKS STORAGE YARD
Locomotive crane lowering pipe into dipping tank at left center. Truckload of pipe in right foreground. In rear, storage shed at left, two-family foremen's house at right.

are connected by private telephones with the service building office.

Gasoline for department use is stored in underground tanks, the larger one having a capacity of 10,000 gal. All walks and drives are paved with concrete, except that the driveway and adjacent space in front of the service building is paved with creosoted wood blocks.

The Springfield water-works is operated by a board of three commissioners, of which the mayor is a member ex officio, Howard M. King is superintendent, Leland G. Carlton assistant superintendent and Alfred R. Hathaway registrar and clerk. Elbert E. Lochridge is chief engineer of the department.

Method Used for Computing Pavement Assessments

Depth Divided Into 100 Units With First 50 Based on Parabolic Ordinates and Last 50 on Arithmetical Progression

By F. H. Austin
Secretary, Currie Engineering Company,
Webster City, Iowa

SINCE the statute governing the assessment of the cost of municipal improvements was changed by the General Assembly of the State of Iowa from a front-foot to a combined area and benefit basis, the preparation of special improvement assessment rolls has been very interesting. The newer statute provides that the cost of any street improvement shall be assessed so as to include one-half of the privately owned property between the street improved and the next street, but that no property more than 300 ft. from the street improved shall be assessed.

Among many different methods of assessment the zone method has been quite commonly used. In this method the territory subject to assessment is divided into zones or strips a certain number of feet in width and parallel to the street improved. A different percentage is given to each zone and the assessment calculated from the cost of the adjacent pavement and the percentage for the zone in which the lot in question lies. This method is somewhat crude, as two or more small lots of the same size might lie within the same zone and receive the same assessment, even if one abutted the pavement and the other was an inside lot. It is evident that the abutting lot should have the larger assessment.

A number of different formulas have been proposed for use, which take into account the depth of the lot, its proximity to the improvement and the width of the pavement. These formulas are based on some sort of progression, usually arithmetical, varying from zero at the assessment limit to some predetermined percentage for the abutting property. The objection is that the abutting lot is usually not assessed high enough, especially when compared with the lot next to the abutting one. There should be a sharp difference between these assessments, even though the abutting lot be very narrow, as it receives by far the major part of the direct benefit.

It has been more or less customary to consider the pavement divided at its center by an imaginary line and to assess the cost of the halves so created to the adjacent property subject to assessment. This works out satisfactorily so long as the blocks are of the same size, but if the blocks on the opposite sides of the street paved are of different depths, the assessment per lot on one side of the street will be more than on the other side.

A number of years ago the writer set about the task of devising a method of procedure that would avoid the shortcomings of other methods, give equitable and uniform results and would be easy and rapid of application. The requirements that seemed pertinent were: (1) The abutting lot should pay by far the greatest assessment. (2) There should be a pronounced drop in the assessment of the lot next to the abutting lot. (3) Lots more remote from the improvement than the abutting one should receive assessments according to arithmetical progression. (4) Similar lots similarly situated with respect to similar pavements should receive the same assessment. (5) Other things being equal, assessments should vary directly as the width of the pavement responsible for the assessment.

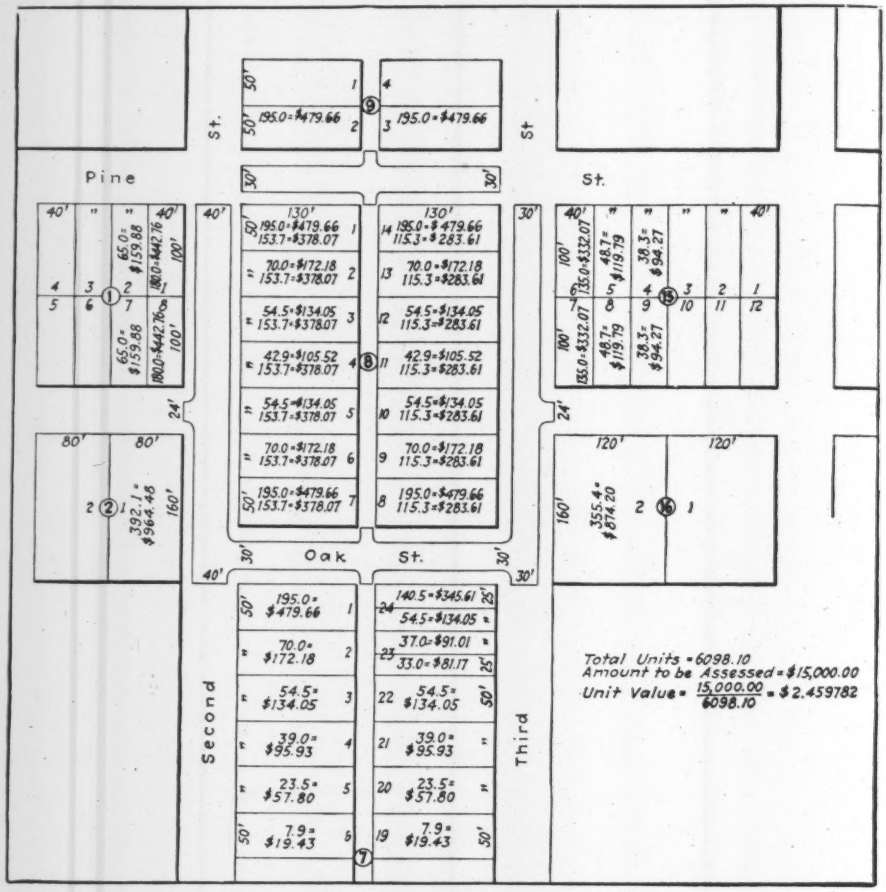
From a canvass of the methods used by cities in Iowa, it was determined that common average practice was to assess 50 per cent to the abutting lot when the depth of the assessment zone was the legal limit of 300 ft. The accompanying table was prepared with 100 units at the maximum legal depth of 300 ft. and 50 units at a depth of 50 ft. The depth for 50 ft. from the improvement was divided as the ordinates to a parabola, with zero at the street line. The interior 50 units were divided in accordance with an arithmetical progression.

The application of the method is best illustrated by the accompanying plat, showing actual assessments for

various lots, computed from the accompanying table. The method of computation for a single lot is shown beneath the plat. The method is believed to comply with the statutes, court decisions and the requirements of equity. The courts have held that an individual assessment is not for any particular part of the pavement but that the improvement should be assessed as a whole.

Getting away from the idea of dividing the pavement on the center line and assessing the halves to the adjacent property does away with the trouble of assessing a lot on one side of the street more than a similar lot on the other side, due to blocks of varying depths. Another advantage is that most of the detail work can be done prior to the completion of construction and the assessment plat and schedule can be filed soon after the completion of the work.

This method of apportioning costs presupposes that each lot has sufficient valuation to sustain its proportionate share of assessment. The statute provides that the assessment for any public improvement shall not exceed 25 per cent of the actual value of the lot at the time of levy. The assessments are not levied until after the improvement is completed, so the valuations are appraised considering the improvement complete.



LOT ASSESSMENTS FOR PAVEMENT ON FOUR SIDES OF BLOCK

The figures shown on each lot are computed from the unit table accompanying this article. Thus, lot 9, block 8, is assessed for the pavements on both Third St. and Oak St. For the Third St. assessment [76.84 (table reading for 130-ft. lot depth) × 30 (pavement width) × 50 ft. (lot width)] ÷ 1,000 = 115.3. Then $15,000 (total cost) ÷ 6,098.1 (total number of units) = $2.459782. Finally, 115.3 × $2.459782 = $283.61, the assessment against lot 9, block 8, for the Third St. pavement.

For the Oak St. pavement the same computation is made, except, because this is an interior lot, table readings for lot depths are taken—that is (67.97, for 100 ft. lot depth, less 50, for 50-ft. depth, gives 17.97), resulting in a unit of 70; and 70 × $2.459782 = $172.18.

TABLE FOR COMPUTING ASSESSMENTS FOR STREET PAVING IN ACCORDANCE WITH DEPTH UNITS

Depth of Lot	0	1	2	3	4	5	6	7	8	9
0	0.0	7.899	10.956	13.262	15.190	16.876	18.397	19.779	21.067	22.267
10	23.405	24.479	25.506	26.485	27.425	28.334	29.218	30.060	30.877	31.679
20	32.451	33.215	33.945	34.663	35.368	36.055	36.734	37.391	38.034	38.671
30	39.290	39.910	40.510	41.100	41.683	42.254	42.823	43.378	43.932	44.471
40	45.006	45.538	46.055	46.567	47.073	47.575	48.070	48.559	49.043	49.531
50	50.000	50.398	50.795	51.190	51.584	51.976	52.367	52.755	53.143	53.528
60	53.91236	54.295	54.676	55.055	55.433	55.809	56.183	56.556	56.928	57.297
70	57.66536	58.032	58.397	58.760	59.122	59.482	59.841	60.198	60.553	60.907
80	61.25899	61.610	61.959	62.306	62.652	62.994	63.337	63.678	64.019	64.357
90	64.69326	65.028	65.361	65.692	66.022	66.351	66.677	67.002	67.326	67.648
100	67.96817	68.287	68.604	68.920	69.234	69.546	69.857	70.166	70.473	70.779
10	71.08372	71.387	71.688	71.987	72.285	72.582	72.877	73.170	73.461	73.751
20	74.03990	74.327	74.612	74.896	75.178	75.458	75.737	76.014	76.290	76.564
30	76.83672	77.108	77.377	77.645	77.911	78.175	78.438	78.700	78.959	79.218
40	79.47418	79.729	79.983	80.234	80.485	80.733	80.980	81.226	81.469	81.712
150	81.95228	82.191	82.429	82.665	82.899	83.132	83.363	83.592	83.820	84.046
60	84.27101	84.493	84.716	84.936	85.154	85.371	85.586	85.799	86.011	86.222
70	86.43038	86.638	86.843	87.047	87.250	87.450	87.650	87.847	88.043	88.238
80	88.43038	88.622	88.811	88.999	89.186	89.371	89.554	89.736	89.916	90.094
90	90.27103	90.446	90.620	90.792	90.963	91.132	91.299	91.465	91.629	91.791
200	91.9523	92.112	92.269	92.426	92.580	92.733	92.885	93.034	93.183	93.329
10	93.47422	93.618	93.759	93.900	94.038	94.175	94.311	94.445	94.577	94.708
20	94.83678	94.964	95.090	95.214	95.337	95.458	95.578	95.696	95.812	95.927
30	96.03997	96.152	96.261	96.370	96.477	96.582	96.685	96.787	96.888	96.987
40	97.0838	97.179	97.273	97.366	97.457	97.546	97.634	97.720	97.804	97.887
250	97.96826	98.048	98.126	98.203	98.277	98.351	98.422	98.493	98.561	98.628
60	98.69336	98.757	98.819	98.880	98.939	98.996	99.052	99.106	99.159	99.210
70	99.2591	99.307	99.353	99.398	99.441	99.482	99.522	99.560	99.597	99.632
80	99.66548	99.697	99.726	99.756	99.783	99.809	99.833	99.855	99.876	99.895
90	99.91249	99.928	99.943	99.956	99.967	99.976	99.984	99.991	99.995	99.998
300	100.00000	.....	.....	.....	.....	.....	.....	.....	.....	.....

Applicable where assessments are made to half the depth of the block but limited to distance of 300 ft. The entire depth to be assessed is divided into 100 units, of which 50 are assigned to the first 50 ft. back from the pavements, these units being divided as are the ordinates of a parabola, while the second or remaining 50 units are divided in arithmetical progression toward the rear. In each case the units from front to rear bear a diminishing share of the burden.

Often a deficiency is created, especially if there are a number of unimproved lots with low values. This deficiency is met out of the general or improvement funds. Sometimes valuation is considered as one of the factors in arriving at the amount of the assessment. In such a case the method that seems most logical is to prepare the assessment as heretofore set out and then to respread the created deficiency in proportion to the valuation. This approaches the statutory provision of paying for deficiencies except that the territory subject to such tax is restricted to the paving district and the city's funds are protected.

The method here described has been used in apportioning the cost of possibly a million dollars worth of pavement with uniformly satisfactory results.

Photo-Echo Study for Acoustics of Buildings

Analyzing Acoustical Properties From Plans and Models Prior to Construction Permits of Correction by Modified Design or Use of Sound-Absorbent Finish

By Kemper Slidell
Engineer, C. F. Burgess Laboratories, Inc., Madison, Wis.

A PROBLEM of acoustics in relation to architectural engineering is the prevention or elimination of echo and reverberation in churches and large assembly halls. Echo is the distinct repetition of a sound, while reverberation is a continual repetition that prevents the listener from understanding the original words. This problem may be solved by changes in the design or by the use of sound-absorbent materials.

At least three methods of diagnosing acoustical ills are used at present. Prof. F. R. Watson's ingenious plan, developed at the University of Illinois, employs an arc light at the focus of a parabolic reflector and can be used only in completed buildings. Dr. Paul Sabine, of the Riverbank Laboratories, makes plaster-of-paris models of cross-sections of auditoriums to be studied. A single sound wave, emitted from the spot where the speaker ordinarily stands, is photographed. Extremely accurate timing is required for using this procedure.

In the third, or Burgess, method, the acoustic properties can be determined from the architect's plans, in advance of construction, by the photographing of light rays on small models showing the points of interference with light from a given point representing the position of a speaker or the source of sound. The significant sections of a room to be studied are usually the floor plan, the longitudinal section and several cross-sections. For purposes of study, under the Burgess method, these features are laid out in miniature on stiff white paper. The section to be studied is placed on a flat surface, and a highly polished strip of metal ½ in. high is placed along the boundary lines of the section. This strip is bent to conform to the outline of the section and is held in place by weights similar to spline weights. These models are usually on a scale of ⅛ or ¼ in. to the foot.

The model section is then placed in a darkened room or cabinet, and a light is displayed at the source of sound. The reflections from the polished metallic strip are found to make the same pattern on the surface of the paper as would be obtained if a draftsman carefully constructed lines representing all the beams of light from the same point and from the reflecting surfaces. Thus light rays instead of sound waves are used and observed. This method gives results more accurate than those of the drafting method, since errors in working out all the numerous angles of incidence and reflection are eliminated. It also obtains results in a fraction of the time required for the latter method. By means of the "echoscope" (Fig. 1), this entire study can be made in a small area. Photographs may be taken by a camera mounted above the models. In the base of the machine, on the "main floor," is placed a cross-section or some other significant section of the auditorium under study. A lighted bulb, representing the speaker or the source of sound, shows what reflections occur. In the illustration this light is at the extreme right of the model. One side of the pyramidal cabinet is removed to show the model in place under the camera.

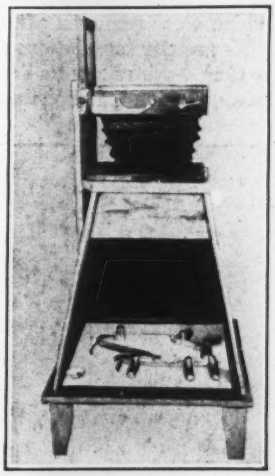


FIG. 1—TESTING ACOUSTICS BY ECHOSCOPE
Model represents an auditorium, with light bulb at source of sound. Reflected rays are photographed by camera above.

There is no easy way of classifying cures for echoes and reverberations, but in many cases a change in the curvatures or angles of surfaces will prevent echoes, and the use of sound-absorbent materials will ordinarily remove the opportunity for reverberation. Installing absorbent materials on troublesome areas is the other usual method of eliminating echo-producing surfaces. Alterations in the walls of a completed auditorium are obviously expensive and tedious, but not often impossible. However, when the plans have just been drawn or when construction has barely started, the correction is simpler and less expensive.

A case in point is the study of acoustical conditions for the church of Our Lady Help of Christians, in Chicago. This church (Fig. 2) is 160 ft. long, 70 ft. wide at the transepts and 50 ft. at the nave, with a height of 55 ft. from the floor to crown of vaulted ceiling. It has seating accommodation for 1,000 persons. The structure is of brick and stone construction, with steel-frame roof. Its interior finish is of sand plaster and a composition called zenitherm, supplemented by the additional acoustical material in the vaulted ceilings.

After construction had begun, it was decided to have a survey and test of the acoustical properties, using the Burgess system. These tests were to include the possible requirements of additional materials and the necessary change in original materials, with an estimate of the cost of such changes in order to insure good acoustical conditions. In the first place, the plans were studied, particularly as to significant portions of the nave and other places where the congregation might be seated. Tests of models were then made with the echoscope, as already described.

As reported by R. F. Norris, the engineer in charge of these studies, the period of reverberation of the church—that is, the period of time during which a given sound remains audible to the ear—would be 9.2 seconds when the building is empty. This condition indicated that the church would lack 3,419 sound-absorption units, each unit represented by 1 sq.ft. of perfectly sound-absorbent material. Several alternative materials having a high coefficient of absorption were suggested, with the number of square feet of each required. The material selected would be applied in a number of places in the auditorium to correct excessive reverberation, and it was also specially important to treat certain surfaces in order to eliminate sound foci. An interior view of the church is given in Fig. 2.

An investigation was made to determine whether there

were any points in the church where the sound might focus and cause disturbance. The course of sound waves issuing from various points was traced by study of the molds, and certain surfaces were found to cause echoes at points designated. Principal among these was the quarter-spherical surface of the ceiling over the altar at the extreme end of the church. It was found that this surface would cause a disturbing echo in a large part of the sanctuary, a condition which would render speaking very difficult from any part of the chancel except from the sides or from a position next to the end wall by the altar. In this latter position the sound focus would be shifted from the sanctuary outward toward the

FIG. 2—CHURCH TESTED FOR ACOUSTIC PROPERTIES

congregation. Speaking would probably be easier, but those persons of the congregation sitting in the front part of the church between the transepts would be annoyed by the echo to a very considerable degree. Other walls, ceilings and vaulted spaces were studied in the same way.

Bids were then asked for the installation of alternative sound-absorbent materials on the surfaces indicated, and a contract was let for furnishing and installing 8,346 sq.ft. of ½-in. hairfelt, covered by membrane glued to the hairfelt, which in turn was glued to the plaster ground coat. This contract was awarded on the basis of guaranteeing a reverberation period not to exceed 2.4 seconds (with one-third of a capacity audience present). The plasterers' scaffolds were left in place for the workmen attaching the sound-absorbent materials. The membrane-covered felt, when fastened in place, represented blocks of stone approximately 13x22 in. The soft material would probably have been inclosed in perforated steel tiles 16 in. square if the ceiling surfaces had been flat, as that treatment is often used successfully on walls and flat ceilings.

On completion of the work the reverberation period was measured in all important portions of the church by the use of a calibrated whistle, whose tones (reverberation periods) were recorded by a stop-watch graduated to hundredths of a second. The reverberation period was found to be almost precisely the amount which had been predicted.

After the dedication of the church entire satisfaction with the acoustics of the building was reported by the priest in charge, Father O'Reilly, and by the architect, Gerald A. Barry, of Jacksonville, Fla. These acoustical studies were made by engineers of the C. F. Burgess Laboratories, Inc., Madison, Wis., under the general direction of R. F. Norris.

Rapid Progress Made on Two Building Jobs

Frame of Steel Structure Put Up in Seven Weeks and That of High Concrete Building in Ten

THE FRAMES of two buildings of similar size in Chicago were put up in a remarkably short time. Both were more than twenty stories in height, but one frame was built of steel and the other of reinforced concrete. A comparison of the two operations provides an excellent opportunity to study the possibilities of making speed with either type of construction.
—EDITOR.

Quick Erection Work on Large Concrete Building

RAPID concrete construction for a period of about ten weeks was a feature in building the 21-story Whitehall Building or apartment hotel at 105 Delaware St., Chicago, averaging about two complete stories per week. Although this rate of erection has been equaled in other buildings by the same contractor, the special feature of this case was in continuing the speed throughout the time required for the construction of such a high building, with frequent setting and moving of forms. In carrying on this rapid work, efficiency in the handling of labor and materials is given as the principal factor assisting the speed.

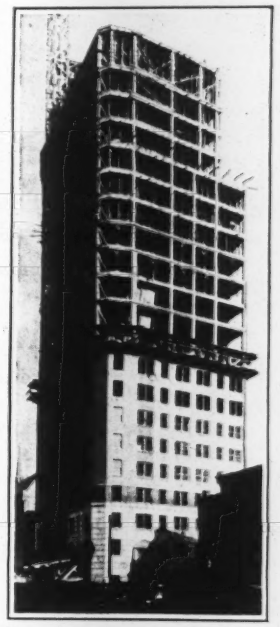
Concreting of the columns and floors was commenced on Jan. 16, and pouring of concrete for the roof was completed on March 28, or in 56 working days, counting ten Saturdays as five days, and excluding Sundays and two legal holidays (Feb. 13 and 23) when no work was done. By April 19 the brick and stone curtain walls and the roof covering were practically completed. The accompanying illustrations show the progress of the work in two months.

For this building, 104x74 ft., there were 3,550 cu.yd. of concrete and 464 tons of reinforcing steel. Owing to the irregular shape of the lot, the framing layout is not symmetrical in plan, but it is practically the same for all stories. Beams and girders support slab-and-joist floors; these joists were built with steel forms or pans, which were removed after the concrete had set. Timber piles are the foundations for footings.

One ¾-yd. mixer was used, serving a ¾-yd. bucket in a two-compartment hoisting tower for the concrete bucket

WHITEHALL APARTMENT, CHICAGO, JAN. 23

and the material hoist. There was no chuting, but concrete was dumped by the elevator bucket into 1-yd. hopper, from which it was charged into wheelbarrows for delivery to the forms. Forms were left in place until test of the specimen cylinders showed a strength of 1,500 to 1,700 lb. Cold weather necessitated inclosing the work with canvas during the first few weeks. The total concreting force was about 24 men, including three or four extra men to insure thorough rodding and working of the concrete for density and complete casing of the reinforcement.



WHITEHALL APARTMENT, CHICAGO, MARCH 23

In accordance with the contractor's regular practice, the concrete mix was not arbitrary, but was governed throughout by the water-ratio method, under engineering inspection. As a result, concrete known commercially as 1:2:4 mix, or 2,000-lb. concrete, had an average strength of 2,500 lb. Similarly, a nominal 1:1:2 mix, or 3,000-lb. concrete, had an average strength of 3,400 lb. Cylinder tests were made at 7, 14 and 21 days. The fourteenth day test was to determine the time of stripping the forms, no form being removed until the test showed a concrete strength of 1,500 to 1,700 lb.

The Adolph Lindstrom Company was the general contractor, with R. A. Northquist as its engineer, and the contractor engaged the Robert W. Hunt Company to control the concrete mix and make the tests of concrete strength. The architects were Klaber & Grunsfeld, with Loewenberg & Loewenberg as associate architects and B. B. Shapiro as structural engineer.

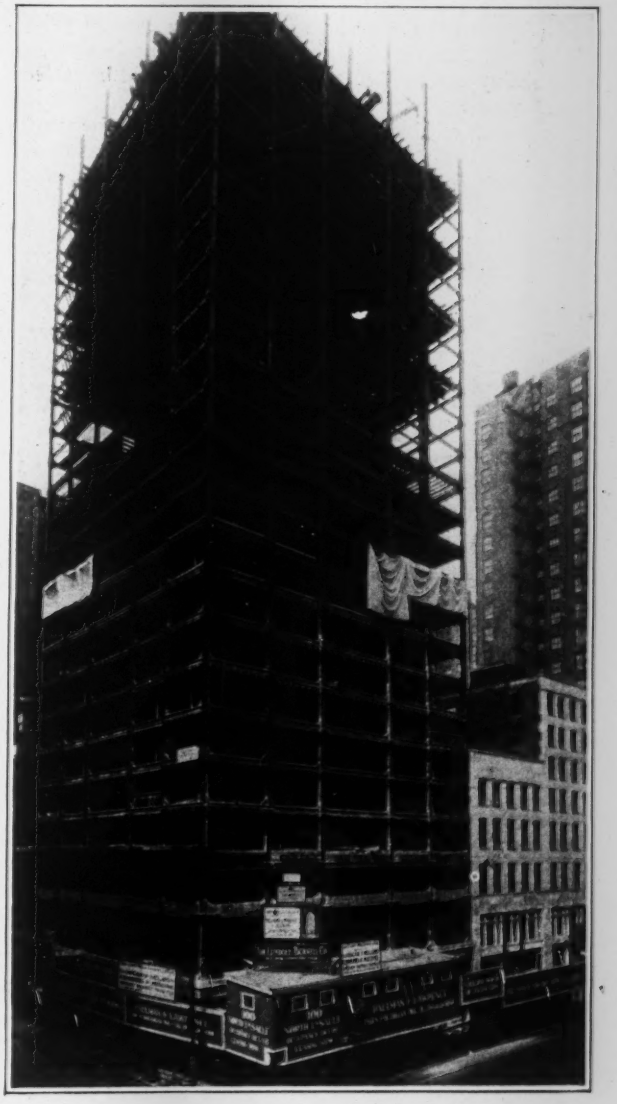
Erect 25-Story Steel Building in 36 Days

STEEL ERECTION on the Lawyers Building, 100 LaSalle St., Chicago, is said to have been completed in less time than for any other building of the same height and with an equal tonnage of steel. This office building is 91 ft. 2 in. x 96 ft. 6 in. in plan and about 290 ft. high, with 25 stories and basement, requiring 1,956 tons of structural steel. All the steel consisted of columns and beams, no girders or trusses being involved.

Delivery of steel began on Feb. 24 and the final delivery was made on April 13, the erection being completed shortly afterward in the record time of seven weeks, or 36 working days. Three days are deducted for bad weather when the erecting gangs could not work, while Saturdays are figured as half days, since the erectors quit work at noon. This entire erection was done on a straight time basis, without any overtime. The erection forces consisted of 50 men. One guyed derrick was used of 15 tons hoisting capacity, with an 85-ft. boom and 100-hp. electric hoist. Material was handled by motor trucks from the local plant of the steel company to the site.

Rapid erection was made practicable largely by prompt delivery of steel and the ability of the erectors to take advantage of this in pushing the work faster than had been scheduled. For their original schedule, the erectors required complete delivery of an entire tier of columns, with two floors of beams and spandrels, in two days, at the rate of three tiers every two weeks. But after the first tier was delivered, the steel company gave each entire tier with corresponding floor beams in 1½ days up to the tenth floor and then each entire tier in one day. From the first tier upward, the delivery was two tiers or stories each week, instead of three tiers every two weeks, while in one week three entire tiers were delivered. There were practically no corrections in the field, owing to accurate fabrication at the shop.

The architects are Graven & Mayger, with Lieberman & Hein as structural engineers. The general contractor was the Lundoff-Bicknell Company. The Gage Structural Steel Company furnished the steel, and the Overland Construction Company was contractor for steel erection. All these are Chicago firms.



STEEL FRAME ERECTED IN 36 DAYS

Backwater Slopes Above Dams

By C. I. Grimm
Civil Engineer, U. S. Engineer Department, Cincinnati, Ohio

BACKWATER slopes above a dam that is constructed in a river channel are usually calculated by the Chezy or a similar formula. The Chezy formula is $v = C\sqrt{rs}$, in which v = velocity in feet per second, r = hydraulic radius, s = slope, and C = a factor dependent upon hydraulic radius, slope and roughness coefficient n.

Where discharges and slopes prior to the construction of the dam are known for various stages in the stretch of the river under consideration, n may be calculated, but where such data are lacking, n must be estimated by comparison with channels that have been rated. The calculation of backwater slopes by this method is laborious and the results may be considerably in error for a channel that is irregular in cross-section, or even for a channel that is regular if it was not rated before the construction of the dam.

The writer has devised a method of computing backwater slopes above dams for channels that have been rated without the dam which involves the general principle of the Chezy and similar formulas, but is simpler and probably more reliable for reasons that will be stated below.

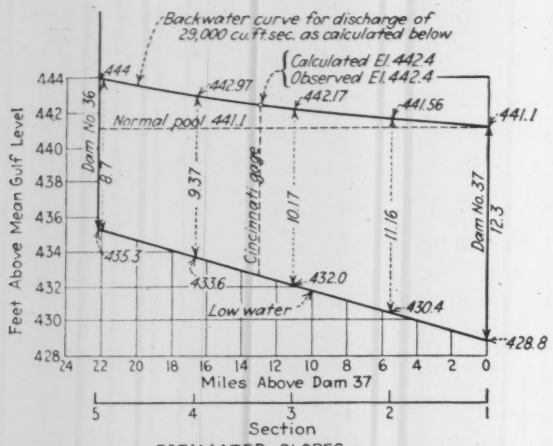
The stretch of river under consideration is, as by usual methods, divided into sections of such a length that there will not be a great variation in the cross-section, and calculations are carried from the dam upstream. The method is illustrated by its application to the pool of movable Dam No. 37, Ohio River, for a flow of 29,000 sec.-ft. This flow brings the river to a stage of the dam equivalent to an open river discharge of 54,500 sec.-ft. For the two conditions, open river and dam up, the factors C and r in the Chezy formula are identical, and therefore the slopes vary as the squares of the respective velocities, or as the squares of the discharges, since areas are equal. By proportion

$$\frac{(Pool\ discharge)^2}{(Open\ river\ discharge\ at\ same\ stage)^2} = \frac{Pool\ slope}{Open\ river\ slope}$$

The rating curves at the two ends of the section give the open river slope, and solution in the equation gives the pool slope required.

Similarly the calculation is carried to the upper end of the pool and the total slope calculated, in this example, as 2.9 ft. Five observations six hours apart with a steady flow of about 29,000 sec.-ft. through this pool showed actual slopes in the entire length of the pool varying from 2.9 ft. to 3.3 ft., and averaging 3.1 ft. An intermediate gage located at Cincinnati showed an actual slope to this point of 1.3 ft., which agreed exactly with the calculated slope. The discharge was estimated from weir openings at both dams, 36 and 37, with allowance for leakage, the estimates for the two points being nearly the same and ranging from 26,000 sec.-ft. to 32,000 sec.-ft. for the period. Further subdivision of this pool would not affect the result appreciably. Without subdivision the estimated slope was 2.7 ft. Record of actual slopes for discharges of 10,000 sec.-ft. and 22,000 sec.-ft. were also obtained and the results from the formula agreed equally well in these cases. It is further observed that for discharges of 10,000, 22,000 and 29,000 sec.-ft. through the pool and an open river discharge of 46,000 sec.-ft. which corresponds to mean pool stage, the slope varies approximately as the discharge squared.

This method of slope computation automatically includes the effect of the factors n and r without computing them, and appears to remove some of the uncertainty involved in their application. The formula has also been checked by applying it to the pool of a fixed dam located 6 miles below Pittsburgh. In this case gage readings are available immediately above the dam and at Pittsburgh, while the discharge is quite well determined from a rated station about 3 miles below the dam. The results were comparable with those obtained in the pool of Dam No. 37. Additional study is contemplated on the Ohio River, particularly in the pool of Dam No. 41, which is 75 miles long and has a greater variation in cross-section than the pool of Dam No. 37. An intermediate gage is located 26 miles from the upper end of this pool.



ESTIMATED SLOPES

Section	Gage height	Open river discharge for gage height in column 2	Slope	Total
1-2	11.73	54,500	$(\frac{29}{54.5})^2 \times 1.625 = 0.46$	0.46
2-3	10.67	47,500	$(\frac{29}{47.5})^2 \times 1.625 = 0.61$	1.07
3-4	9.77	41,500	$(\frac{29}{41.5})^2 \times 1.625 = 0.80$	1.87
4-5	9.03	37,000	$(\frac{29}{37})^2 \times 1.625 = 1.03$	2.90

Date	Calculated discharge No. 36	Calculated discharge No. 37	Actual slope
6-13-26	31,900	26,500	3.3
6-13-26	31,600	26,600	3.1
6-13-26	31,400	27,300	3.1
6-14-26	31,000	27,300	3.0
6-14-26	29,500	29,400	2.9

Estimated slope without subdivision $= (\frac{29}{45})^2 \times 6.5 = 2.70'$

Bear traps down

BACKWATER CURVE
(Estimated)
Pool No. 37
OHIO RIVER

RESERVOIR SLOPE CALCULATIONS AT DAM NO. 37, OHIO RIVER

Use of Steel Ties on South African Railways Increasing

The South African Railway administration during the last four years has been using an increasing number of steel railway ties, their use having been found to be more economical than wooden ties on light branch lines and on certain sections of the main system. Although it is not contemplated to use steel ties exclusively, the administration favors their use wherever possible.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Tensile Working Stresses for Rivets

Sir—The paper "Tensile Working Stresses for Rivets" by Prof. C. R. Young (*Engineering News-Record*, Feb. 2, 1928, p. 188) has thrown much light on a dark subject and his statement that the initial tension on a rivet has no effect on its carrying capacity is fairly conclusive, borne out as it was by the test results. Initial rivet stress must not, however, be forgotten or disregarded. H. E. Wessman, in your issue of April 12, 1928, p. 602, assumes a condition wherein the initial rivet stress might be serious, but the condition shown is most unusual for a rivet, and the conclusion therefore is misleading.

In Fig. 1 the springs are in compression and the rivet in tension, say to the amount of 100 lb. There will be a pressure between spring faces F of 100 lb., and a pressure of 100 lb. under each head of the rivet. Apply a pull P of 50 lb., and the pressure between faces F will be reduced by 50 lb., but the pressure under each rivet head will still be 100 lb. Increase P to 100 lb., and the spring ends no longer react against each other, being relieved by the forces P. Pressure of the springs on the rivet heads is still 100 lb. Only when P becomes greater than 100 lb. will there be a change in length of springs or stress in rivet.

Rivets in tension bind together two or more bodies of material and prevent them from separating. Fig. 2 shows a typical condition. The gripped material is in compression and the rivets in tension. Apply a load P less than the initial stress in the joint. This will tend to sever the joint. But the pressure under the rivet heads, which is the same as that on faces F, already tends to do this, and the pull P will only reduce the pressure on faces F, for if P becomes

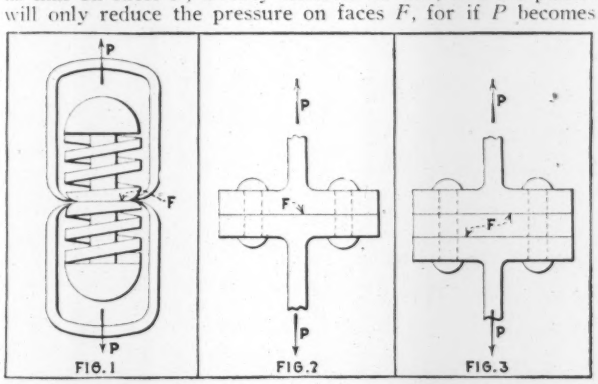


FIG. 1

FIG. 2

FIG. 3

equal to the initial rivet tension, the faces F will be just on the point of separating. Between the limits of P = zero and P = initial rivet tension there will be no change in the thickness of the material in compression (since the compression in the joint has not been changed) and no increase in rivet length, therefore no change in tension in the rivets. The materials are all elastic and the condition is identical with that shown in Fig. 1.

A case having some of the elements of that assumed by Mr. Wessman is shown in Fig. 3, where a filler is used between the active members. Apply a load P and it will cause a reduction of pressure on the faces F, but this reduction will be less than P, because of the expansion of the filler as the compression on it drops. To reduce the pressure on the faces F to zero the active members must be reduced in thickness, or the rivets increased in length, or a combination of the two must occur; in any case the result will be an increase in rivet stress beyond that initially set up. A very small elongation of the rivets will release the pressure on the filler, after which the condition becomes as in Fig. 2.

Another way to consider the action is that of stored energy. In the first case, Fig. 2, the forces P have to overcome the stored energy before proceeding to the work of lengthening the rivets. In the case of the filler the forces P have to overcome the energy stored in the active plates, but will receive reinforcement from that stored in the filler.

The tests of Professor Young showed greater strength in short than in long rivets. This is to be expected. The short rivet will receive the more thorough semi-cold working, will fill the hole better, therefore will have greater area, and the shank will be of more uniform size and less subject to necking.

Since, in the test by Professor Young, no filler was used, his statement probably anticipated none; and since the effect of the filler material is small, particularly so as compared with other variables, it would seem that his statement is practically correct. The reports of his further tests will be looked for, and will include, we hope, the common case of rivets in tension in angle connections.

ERNEST D. FRANCIS,
Associate, Weeks & Day,
Architecture and Engineering.

San Francisco, Calif.,
April 27, 1928.

Sir—If a few additional words may be permitted upon the recently discussed subject of rivet tension (Prof. C. R. Young, *Engineering News-Record*, Feb. 2, 1928, p. 188, and H. E. Wessman, *Engineering News-Record*, April 12, 1928, p. 602), the writer would like to express his view that both Professor Young and Mr. Wessman are right. The difference in their conclusions is due to a difference in assumptions.

Professor Young assumes the added load to be applied to the plates (Fig. 1) intervening between the rivet heads, so

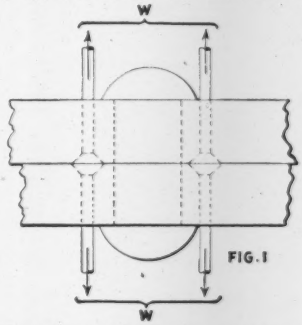


FIG. 1

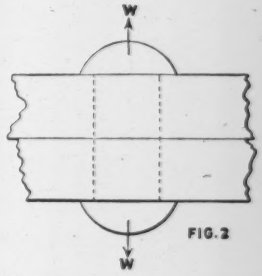


FIG. 2

that the tendency is to open up a space between the plates. This tendency reduces the compressive stress passing from plate to plate, this stress becoming zero at the instant that the plates actually separate, and this obviously occurs when the added load equals the initial tension in the rivet. Hence, up to this point, the rivet stress is constant and equal to the initial tension.

Mr. Wessman applies the added load directly to the rivet heads (Fig. 2), so that the tendency is to open up a space between the head and the outer plate. Here the initial compressive distortion in the plates will be relieved by the added load and a portion of this load will produce additional rivet tension. If the plates are assumed infinitely rigid, the rivet heads will leave the plates as soon as the added load exceeds the initial tension by a differential amount, so that here, too, the added load could not increase the rivet stress until it equaled the initial tension. But if the plates are elastic and of the same material as the rivet, the added load will be applied to a system consisting of plates and rivet, and as the distortions caused by it must be equal in these two elements, the added unit stresses in rivet and plates must also be equal. Hence, since W acts solely upon the areas of the rivet and the plates, the value of this added unit stress will be $S_W = W \div (A_R + A_P)$, where W = added load, A_R = sectional area of rivet, A_P = area of plate compressed by rivet in question.

If the initial unit tension in the rivet is S_T, the total unit tension in the rivet will then be $S = S_T + S_W = S_T + W \div (A_R + A_P)$.

The German experiments referred to by Professor Young showed that the initial tension was about equal to the lower elastic limit, or say S_T = 31,000 lb. per sq.in.

If we assume rivets spaced in perpendicular rows with a pitch n in each direction, $A_P = n^2 - A_R$. Hence $A_R + A_P = n^2$.

If we say $n = 3$ in., then $S = 31{,}000 + (W \div 9)$.
If $W = 10{,}000$ lb., $S = 31{,}000 + 1{,}100$.

The added stress in rivet is therefore less than 4 per cent of the initial stress.

The writer thinks that the true condition in practice is more like that assumed by Professor Young than that assumed by Mr. Wessman, but in either case if we accept the results of the German experiments before referred to and limit the added load W to a reasonable figure, the unit stress in the rivet would seem never to be increased above about 2 or 3 per cent, which would be properly negligible. Professor Young's experiments substantiate this conclusion.

The writer is not arguing for the use of rivets in tension, but is merely endeavoring to reconcile two conflicting views regarding a matter whose essential mechanical aspects really seem to admit of no argument.

FRANCIS P. WITMER,
Director, Department of Civil Engineering,
Philadelphia, Pa. University of Pennsylvania.
May 5, 1928.

Sir—In his letter to *Engineering News-Record*, April 12, 1928, H. E. Wessman takes exception to the writer's assertion (*Engineering News-Record*, Feb. 2, 1928, p. 188) that no increase of tensile stress in a rivet is possible until the load imposed has exceeded the initial tension existing in the rivet. His dissent is, however, based on the impracticable assumption that the tension is applied at the extreme points of the rivet heads. In any actual construction the tension will be applied to the shoulders of the rivet heads by the connected plates or parts, acting in a measure as opposing stirrups or U-straps. Upon such a basis, which seems a reasonable one, the conclusions expressed by the writer appear to be justified. C. R. YOUNG,
Toronto, Ont., Professor of Structural Engineering,
April 23, 1928. University of Toronto.

Future Land Reclamation

Sir—In the article on p. 695 in your issue of May 3, Dr. F. H. Newell presents some sound and timely arguments against the wholesale and indiscriminate reclamation of land. Obviously his purpose is to discourage favorable consideration of specific projects by the present Congress. It would be a mistake, however, it seems to me, to let the matter stand where he has left it, lest we shut our minds permanently against this form of activity and thus err at the other extreme.

As Mr. Newell points out, the actual mechanization of agriculture is now well under way and has resulted in increasing the output per worker and also the amount of land that one man can handle. Profits in mass production depend primarily upon a large volume to which to apply a narrow margin between producing cost and selling price. This means that the most efficient use of power machinery requires large blocks of favorable terrain upon which to operate. Whether such blocks will come through consolidation of individual farms or through reclamation of selected areas or both is a question for the future to decide. Certainly, in this new era, we may count upon the prevalence of more selectivity in the choice of land and more intelligence in its treatment.

A beneficent aspect of land reclamation, even at the present moment, and one seldom considered in blanket condemnations, relates to the draining of small wet spots in cultivated fields. According to the 1920 census some 39,000,000 acres in the United States come under this category, the reclamation of which would lower costs of field operations on good land very materially. It is estimated that in six Mid-Western states this decrease would amount to 30 per cent or more. Moreover, by eliminating these "parasite" acres and making them carry their full share of the production load, the capital investment in land actually tillable would fall from an average of $135 an acre to $77, thus lowering fixed interest charges that must be earned before profits begin. Substantially the same line of reasoning may be applied in the realm of land clearing and in the prevention of soil erosion.

For many years the writer has held that the whole field of land utilization or land planning is one that deserves exhaustive study on the part of some centralized governmental body. Only in this way can a constructive national policy be formulated. Q. C. AYRES,
Associate Professor of Agricultural Engineering,
Ames, Iowa, Iowa State College.
May 9, 1928.

Causes of St. Francis Dam Failure

Sir—In his letter in *Engineering News-Record*, May 17, p. 789, M. M. O'Shaughnessy, consulting engineer, takes issue with my communication in the issue of April 19, p. 688, in which he assumed I recommended a cutoff wall under the downstream toe of the dam instead of the upstream.

The word "cutoff" should not have been used, because a careful reading of my article would show what I meant was to build the downstream portion of the dam deep enough so that the burden of rock against the dam would prevent sliding, no matter how low the coefficient of friction, and that could be done without making the downstream portion of the dam impervious and thus prevent upward pressure due to the confined water.

To secure imperviousness the cutoff should be placed under the upstream toe, which has always been my practice.
Philadelphia, Pa. J. W. LEDOUX.
May 18, 1928.

Welding and City Building Codes

Sir—In your issue of May 17, 1928, p. 766, giving a description of an arc-welded factory building recently completed for the General Electric Company at Philadelphia, you only gave a portion of the requirements asked by the Philadelphia bureau of building inspection. As this class of building is coming into vogue, I am sending you the full text of the requirements asked by the bureau in the hope they may be of interest to other bureaus that will sooner or later have to deal with the problem of welding. The requirements are as follows:

1. In trusses, gusset plates may be eliminated provided suitable shapes be used so that there is ample room for welding. In all cases the bureau reserves the right to reject any shape which it feels is not suitable for welding or for the stresses to which the piece will be subjected.

2. Allowable safe working stress for a ⅜-⅝-in. fillet shall not exceed 3,000 lb. per linear inch of fillet.

3. The deposit of any fillet once begun shall be continuous for the length of weld. [This does not preclude intermittent welds but refers to short welds.—EDITOR.]

4. The bureau reserves the right to require tests on any welded structure if the question of safety and stability is involved.

5. In welding, only competent welders trained in the art of welding shall be employed.

6. Before any welded structure is started, a competent trained engineer, skilled in welding, must be furnished by the owner and all work must be done under his personal supervision.

7. In equipment, only arc welding is to be used.

8. The owner must take out the permit.

Philadelphia, Pa., MANTON E. HIBBS,
May 23, 1928. Chief Engineer,
Bureau of Building Inspection.

Eccentric Bending in Columns

Sir—In reading over my letter which was published in your issue of May, 3, p. 708, I find that in trying to make a statement brief in the last sentence of the second paragraph I have in reality made a wrong statement. The intended idea is that the moment Px never exists in a column except at the top when the load is at the top and the connection at the top does not take moment and that the moment at and near the center of the unsupported length is relatively very small except when the column is merely supported at the bottom. W. C. SPIKER,
Atlanta, Ga., Consulting Engineer.
May 16, 1928.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Engineers Thanked for Public Service at New York

In recognition of distinguished public service to the city of New York an illuminated resolution has been presented to the New York Section of the American Society of Civil Engineers and to the New York Chapter of the American Institute of Architects by the Board of Education of the City of New York for the services rendered by committees of those two organizations in recommending to the city certain changes in its practices in the construction of school buildings following the widespread report that much of the work on new school buildings in New York City was unsatisfactory. The committee representing the New York Section consisted of Jacob S. Langthorn, J. Vipond Davies and C. H. Stengel. The architects were represented by D. Everett Waid, Charles Butler and Charles H. Higgins.

Boulder Dam Survey to Be Made

Although the adjournment of Congress has eliminated any possibility of action on the Swing-Johnson Boulder dam bill until December, a joint resolution passed just before adjournment provides for a thorough investigation of both the economic and the engineering features of the proposed dam. This will be made by a board of five engineers and geologists to be selected by the Secretary of the Interior, with the approval of President Coolidge.

German Engineers Here To Inspect U. S. Water And Sewerage Systems

NINE sanitary engineers connected with either the German government or various German cities arrived in New York on May 27 and will remain until July 6 for the purpose of visiting waterworks and sewerage systems.

The delegation is headed by Privy Councillor Dr. Max Beninde, president of the German Government Institute for Water-Soil- and Air-Hygiene, and his co-worker, Prof.-Dr. Bernhard Buerger. Other members of the party are: Dr.-Ing. h.c. Heinrich Helbing, director of the Emscher & Lippe Organization, Essen; Dr.-Ing. Max Prüss, naval engineer, chairman of the sewage department of the Emscher & Lippe Organization; Fritz Langbein, city engineer, director of the sewage-works of Berlin; Karl Fehring, architect, director of public utilities, Moers; Fritz Mieder, architect, member of the Leipzig city council; Dr. Willi Hilland, member of the International Dye Trust, Elektron-Nord, Bitterfeld; Otto Mohr, director of the Rhenish Sewage Company for City Cleaning in Wiesbaden.

Besides New York City, the delegation will visit Atlantic City, Baltimore, Washington, Pittsburgh, Indianapolis, Chicago, St. Louis, Kansas City, Salt Lake City, Yellowstone Park, Antigo, Wis., Milwaukee, Detroit, Cleveland and Buffalo. It will sail for Europe at midnight, July 6-7.

AERIAL VIEW OF ATLANTIC CITY CONVENTION HALL, NOW UNDER CONSTRUCTION

The building is 675x350 ft. The trusses shown have a clear span from wall to wall, with center pins 135 ft. above the floor. The hall was designed by Lockwood, Greene & Company, of Boston, and is being built by the M. B. Markland Company, contractors, of Atlantic City, N. J.

Work Begun on San Francisco Bay Highway Bridge

Construction work on the new San Francisco Bay bridge connecting San Mateo and Hayward, Calif., has been formally started by a ground-breaking ceremony. The bridge will be the final link in the Lincoln Highway, providing a direct connection between San Francisco and towns across the bay. This will be the longest highway bridge in the world—7 miles between shores, with approaches of 5 miles additional length. It is planned to open the bridge in June, 1929.

Baltimore Engineer Appointed

The temporary appointment of Herbert J. Leimbach as supervising engineer of the Public Improvement Commission of Baltimore, Md., has been made permanent by action of Mayor Broening, in spite of opposition based on the grounds that several of the five candidates examined by the civil service commission of the city were said to be better qualified for the position. The Public Improvement Commission is an agency apart and separate from the regular municipal organization, created to provide a non-political check on large expenditures. The chairman of the commission, Robert Garrett, was the leader of the faction opposing the appointment.

Portland Cement Association Holds Spring Meeting

The spring meeting of the Portland Cement Association was held in the Hotel Biltmore, New York City, on May 21-23, with an attendance of 280. The general session for discussion of technical problems and mill practice included a symposium on coolers, and consisted of papers on "Unax Coolers," by W. J. Fullerton, plant manager, and E. S. Hill, superintendent, Howe's Cave plant, North American Cement Corporation, and on "Pressure Coolers," by W. M. Harbaugh, field engineer, Lehigh Portland Cement Company. A paper on "Stores Control" was presented by R. B. Fortuin, assistant to general manager, Pennsylvania-Dixie Cement Corporation, Nazareth, Pa. F. R. McMillan, director of research, Portland Cement Association, Chicago, presented a discussion of "Factors Affecting Durability of Concrete."

Formal award of safety trophies for 1927 was made to the following mills: Alpha Portland Cement Company, Ironton, Ohio; Alpha Portland Cement Company, Plant No. 3, Martins Creek, Pa.; Canada Cement Company, Ltd., Belleville, Ont.; Canada Cement Company, Ltd., Hull, Que.; Cowell Portland

Cement Company, Cowell, Calif.; Kansas Portland Cement Company, Bonner Springs, Kan.; Lehigh Portland Cement Company, Iola, Kan.; Lehigh Portland Cement Company, Plant No. 3, Newcastle, Pa.; San Antonio Portland Cement Company, San Antonio, Tex.; Universal Portland Cement Company, Duluth, Minn.

The sessions closed with a formal dinner on Wednesday evening, at which the principal speaker was Merle Thorpe, editor of *Nation's Business*, Washington, D. C.

At the business session on the last day W. D. Lober, president, Vulcanite Portland Cement Company, presented to the association the original letter, written by B. F. Stradley, of the Vulcanite company, dated Sept. 4, 1902, which brought together in New York City representatives of 24 cement companies and resulted in the formation of the Portland Cement Association. The letter will be placed in the archives of the association.

Ferguson Dock Patent Again Upheld

Suit for infringement of the Ferguson patent 1,089,405 for a reinforced-concrete dock and pier was decided in favor of the patent by Judge Tuttle of the U. S. District Court at Detroit on June 2. The decision was against the Detroit Rail & Harbor Terminals Company, which built a concrete wharf three years ago. The defense denied infringement and also attacked the validity of the patent. The latter had been upheld in the same court in two prior suits. The decision in the present case granted the patent a broad interpretation of its claims, and held that reinforced-concrete docks over water, built integrally and supported on wooden piles, come within its claims. Brace piles holding the dock against outward thrust were held to be an equivalent of the bracing rod or wall connections between front wall and floor, of the patent.

A prior decision and its affirmation on appeal were reported in *Engineering News*, Nov. 16, 1916, p. 961.

Passaic Consolidated Water Co. Asks Halt to Purchase

Following the appointment of a condemnation commission to fix the price to be paid by Paterson, Passaic and Clifton, N. J., for the water-works of the Passaic Consolidated Water Company, the company announced that it would apply for writ of certiorari on the ground that the condemnation petition does not comply with the state law of 1923 requiring the specification of all holdings to be condemned. It is announced that an amendment to the petition will be filed. The condemnation proceedings are a sequel of an offer of $8,500,000 for the property of the company, this valuation having been fixed by the Passaic Valley Water Commission, a body created for that purpose under a state law requiring a valuation and offer of purchase before condemnation proceedings are begun. It is said that the company values its property at $20,000,000.

Structural Engineers Organize Professional Society

Structural engineers in New York City have just formed a professional society, the "Structural Engineers Society of New York," intended to create a better understanding and bond among individuals engaged in the profession, eliminate injurious practices and promote sound professional practices, and in general aid in the maintenance of proper standards and sound relations with other building interests and with the general public. F. A. Burdett has been elected president of the society, and L. A. Ball and N. A. Richards, vice-presidents. Elwyn E. Seelye is secretary and H. R. Burroughs is treasurer of the new organization.

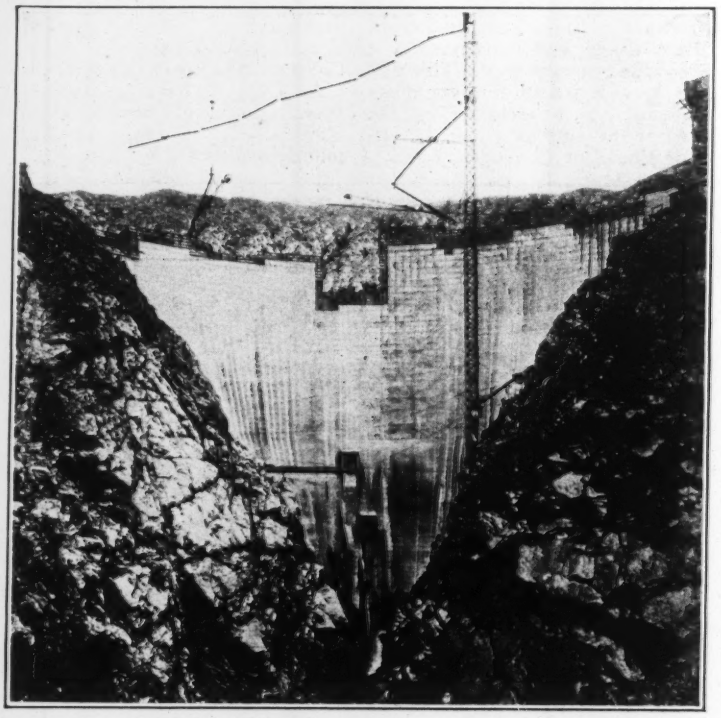
New York City Technical Men Get Higher Pay

Distribution of the salary increases authorized for engineering employees of the city of New York has been passed by the Board of Estimate and Apportionment and approved by the Board of Aldermen in accordance with the plan worked out by Budget Director Kohler. Under the new scale all technical employees have been placed in two grades, the lower to receive from $2,160 to $3,000 per year, the higher from $3,100 up. The increases are distributed as follows: 11 per cent of the men receive less than $300, 53 per cent receive $300 to $600, 25 per cent receive $600 to $900, 7 per cent receive $900 to $1,200, and 4 per cent more than $1,200. The total amount available for increases is about $600,000. The schedule affects 1,450 men, without including 500 in the Borough of Queens, who are expected to receive equal consideration in the near future. Because of recent changes in administration in Queens it has been decided to defer action there for a time.

Welding Prizes Awarded

The prizes offered by the Lincoln Electric Company, Cleveland, Ohio, for the most original and practical paper on the art of arc welding were distributed at the opening session of the spring meeting of the American Society of Mechanical Engineers in Pittsburgh, May 14. James W. Owens, director of welding for the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., won the first prize of $10,000 for a paper entitled "Arc Welding, Its Fundamentals and Economics," being a treatise on the fundamentals of arc-welding design and shop practice and an analysis of its industrial ap-

PACOIMA DAM, NEAR LOS ANGELES, NEARING COMPLETION



Construction view of Pacoima Dam taken on March 7, 1928. This structure is being built by Bent Brothers for the Los Angeles County Flood-Control District, E. Court Eaton, chief engineer, and is on Pacoima Creek, a small tributary of the Los Angeles River, about 25 miles from Los Angeles. It is a constant angle arch with an upstream crest radius of 340 ft. and an upstream base radius of 171 ft. The total height is 265 ft. The dam contains 220,000 cu.yd. of concrete and will provide a reservoir capacity of 12,000 acre-ft.

plications and possibilities. The award for the second best paper submitted, $5,000, was won by Henry Dustin, professor in the engineering school of the University of Brussels and director of the laboratory for material testing. The third place award, $2,500, was given to Commander H. E. Rossell, construction corps, United States Navy, instructor in mathematics at the United States Naval Academy at Annapolis. Honorable mention was given to the papers submitted by Frank B. Walker, Winthrop, Mass., and B. K. Smith, president of the Big Three Welding & Equipment Company, Houston, Tex.

Seventy-seven papers were submitted, thirteen from residents of foreign countries. Professor Dustin's paper deals with the strains set up in welded joints and methods of calculating such strains. Commander Rossell's paper was entitled "Electric Welding of Ships' Bulkheads and Similar Plated Structures." Mr. Smith's honorable mention paper was entitled "Stable Arc Welding on Long Distance Pipe Lines." The other honorable mention paper, by Frank B. Walker, was entitled "Theory and Application of the Base Plate Arc Welded Rail Joint."

The judges were L. F. Alford, chairman; S. W. Miller, American Welding Society; Comfort A. Adams, American Institute of Electrical Engineers; Henry Goldmark, American Society of Mechanical Engineers; F. T. Llewellyn, American Society of Civil Engineers; George K. Burgess, U. S. Bureau of Standards; W. F. Durand, and Robert H. Fernald. J. C. Lincoln and J. F. Lincoln, of the Lincoln Electric Company, were advisory members of the judging committee.

Southern Pacific to Bridge Carquinez Strait

The Southern Pacific Railroad has announced its decision to apply immediately to the War Department for approval of plans for a double-track bridge across Carquinez Strait, in California, to replace the Benicia-Port Costa train ferry, which transcontinental trains to San Francisco must now cross. Construction is to start immediately official sanction is obtained, and is to be completed in two years. The proposed bridge will be 6,000 ft. long, consisting chiefly of steel trusses 408 ft. long, and with a 327-ft. lift span over the channel. The other spans will have a 70-ft. clearance. The line change involved will total 6.13 miles, all of which will be double-tracked.

Special Taxes May Include Cost of Supervision

The Missouri Supreme Court, by a recent decision, has confirmed the right of a city to assess the cost of engineering and inspection service on street, alley and sewer improvements upon the benefited property owner. Heretofore the property owners have been assessed for material and labor costs only.

Washington Notes

Chief of Engineers Allocates Fund for Mississippi Work—Canadian Boundary Streams

By Paul Wooton
Washington Correspondent

OF THE $25,000,000 available for flood-control work on the Mississippi, $9,000,000 has been allocated by the Chief of Engineers for revetment work; $8,400,000 for levees on the main river; $1,500,000 for the Bonnet Carré spillway; $2,000,000 for dredging and miscellaneous work; and $328,000 for surveys. This leaves a balance of $2,260,000 for contingencies and for work on the tributaries.

All of the $25,000,000 appropriated was allotted to work which does not come within the purview of the board of three which will harmonize differences between the plan of the Army engineers and that of the Mississippi River Commission. It is unlikely that any of these differences will have been settled prior to the convening of Congress in December, when further sums can be appropriated for any further work that can be undertaken at that time.

Every effort is being made to take full advantage of the present working season. General Jadwin, Chief of Engineers, is particularly anxious to start work on the south levee of the Bonnet Carré spillway, and he has every assurance that New Orleans interests will co-operate to insure the early obtainment of the necessary right-of-way. When the south levee is completed, General Jadwin points out, New Orleans will be practically safe from flood, since the main river levee could be opened in an emergency, and excess water diverted into Lake Pontchartrain. This would be, of course, at the sacrifice of overflowing a considerable area of land north of the spillway site.

It is thought that the first activity of the board of three will be a trip down the river to decide upon the surveys that will be necessary and to conduct public hearings. These hearings are expected to include the questions involved in the spillway situation at New Orleans; the diversions through the Atchafalaya and the Boeuf basins; the riverside spillway opposite Cairo; and in the differences in the height of main river levees. These constitute the main differences between the two reports. While there is no difference as to the Bonnet Carré spillway, the whole spillway question at New Orleans must be considered, since the comprehensive plan of the Mississippi River Commission proposes an additional 250,000-sec.-ft. spillway below New Orleans.

Inland Waterways

Expansion of the inland waterways transportation operations of the government is assured by the approval of the barge line bill, signed by the President shortly before Congress adjourned. In conference, the La Follette amendment precluding the sale of separate units of the operations was altered so that "the facilities of the corporation on the Mississippi River and its tributaries shall be considered one unit and those on the Warrior River and its tributaries a separate unit" for the purposes of lease or sale. Under that amendment the lower Mississippi operation, which is on a paying basis, may not be sold separately, but could be sold in connection with the operation on the upper Mississippi. The Warrior service would be open for separate sale.

Canadian Boundary Streams

Investigations of several streams along the boundary between the United States and Canada where there are questions concerning the waters that affect international interests are being undertaken by the U. S. Geological Survey. The investigations are being made for the State Department with a view to securing for that department technical advice on these questions which come before the International Joint Commission in carrying out the terms of the treaty of Jan. 11, 1909, between the United States and Great Britain. Among the streams to be studied are Roseau River, a stream draining a portion of northwestern Minnesota and flowing into Manitoba, where it joins Red River; Milk River, a stream rising in Montana, flowing northward into Alberta and then doubling back in the United States, where it ultimately joins the Missouri River; St. Mary River, rising in Montana and flowing into Alberta and into streams draining into Hudson Bay; Kootenai River, which rises in British Columbia, flows into northwestern Montana, thence into Idaho and then returns to British Columbia, where it empties into Columbia River; Clark Fork, draining an extensive area in the United States but flowing in British Columbia for the last few miles, where it joins Columbia River, and Skagit River, rising in British Columbia and flowing through Washington to the Pacific Ocean.

The questions on the streams relate to drainage, restrictions of channel, irrigation use, etc. Permanent gaging stations will be established to show the distribution of flow from the drainage basins under consideration. River profiles and topographic maps along the banks of certain streams will also be made to determine the effect of overflow which may result from contemplated reclamation, power and other projects. Field work is now in progress on the St. Mary and Milk rivers under the direction of W. A. Lamb, U. S. Geological Survey district engineer for Montana, and on the Kootenai River under the direction of C. G. Paulsen, U. S. Geological Survey district engineer for Idaho. Field work on other rivers will be started in the near future. In carrying on the investigation, there is close co-operation between the United States and Canadian officials, which insures that the data collected on both sides of the boundary will be mutually acceptable and of a uniform standard.

European Brevities

THE OPENING of a new railway tunnel connecting Canfranc, Spain, and Les Forges d'Abel, France, is scheduled for July 18. President Doumergue and King Alfonso will be present at the ceremony.

STEEL HOUSE building, started in Germany in 1926, is rapidly progressing. One firm, a subsidiary of the United Steel Works, is reported to be unable to accept all orders in spite of the fact that production has been increased 600 per cent within the year.

LONG DISTANCE gas distribution is making progress in Germany despite opposition against the concentration of gas production in the three centers—the Ruhr, and the Saxonian and the Upper Silesian coal districts. Recently the Province of Hannover ($2\frac{3}{4}$ million inhabitants) signed a contract for the supply of gas from the Ruhr, which is 250 to 350 miles distant.

THREE TURBINES claimed to be the largest yet installed in Europe will be placed in the new plant of Ryburg-Schorstedt on the Rhein, Switzerland. These are Kaplan turbines with an effective power transformation of 1,000 hp. for each meter fall of the water. It is said that the largest turbines heretofore installed were in Sweden in the Lilla Edet plant, each of which produces 676 hp. for every meter fall of the water.

A CONTRACT for regulating the main tributaries of the Magdalena River in Colombia, South America, has been granted to Julius Berger A.G., Berlin. This firm in 1926 was given a contract by the Colombian government for the regulation of the main Magdalena River. It is planned that all of the work will be finished in 1932.

TWO STEEL companies in Czechoslovakia are beginning the construction of large steel sheet mills in North Moravia, these mills to utilize the continuous process for rolling sheets and strips, which has recently been developed in the United States.

THREE LARGE waterway projects are under construction at the present time in Germany. The first is the Rhine-Danube canal, three-quarters of which is completed and open to traffic. The second is the so-called Midland Canal joining the Rhenanian-Westfalian industrial district with central Germany; it is predicted this canal will be completely in service in two years. The third is the Hansakanal, from the Ruhr to Hamburg, which is expected to be completed in about eight years.

TRANS-PERSIAN RAILWAY contracts have been signed involving 470 miles of the projected 1,070-mile line. The German firms Julius Berger A.G., Berlin, Siemens Bauunion and Ph. Holzmann have this first contract, which represents practically the northern half of the line. According to the firm Julius Berger, work will be started in May, the 470 miles to be completed within three years. A number of difficulties are foreseen on this work, especially with regard to transporting material. It must go via the Black Sea, the Caucasus Republic, and by ship on the Caspian Sea. The cost of the German part of the railway is estimated to be $80,000,000.

A HYDRO-ELECTRIC PLANT (100,000 hp.) near Riva, Italy, on the Lake of Garda, has recently been completed on a canal about $3\frac{1}{2}$ miles long, which connects the lakes of Ledro and Garda. There is a difference in elevation between the lakes of 2,000 ft. Power will be used chiefly for train service over the Brenner frontier and will also be carried by high-tension cables to northern Italian towns. At present there are three other plants totaling 120,000-hp. capacity under construction in the mountains which will serve for further electrification of the railways.

Personal Notes

JAMES E. HEWES, formerly general manger of the Albany Southern Railroad, is now engaged in general contracting at North Chatham, N. Y.

JOHN V. ZAHLEN, hydraulic and structural engineer, for the past seven years engaged on design and construction of hydro-electric developments on the Pacific Coast with the Western States Gas & Electric Company, the California Oregon Power Company and the Sierra & San Francisco Power Company, for the Byllesby Engineering & Management Corporation of Chicago, is now connected with hydro-electric developments on Devils River near Del Rio, Tex.

J. E. ARMSTRONG, assistant engineer, Canadian Pacific Railway, has been appointed assistant chief engineer, with headquarters at Montreal.

A. R. KETTERSON, assistant engineer, Canadian Pacific Railway, has been appointed assistant bridge engineer.

JACOB J. DEL BOURGO has recently returned from a trip to Japan and has opened an office for consulting practice at 1431 Broadway, New York City. Mr. Del Bourgo was formerly connected with Dwight P. Robinson & Company and the Knickerbocker Ice Company in the design of industrial buildings. He has also worked on the design of the New York subways.

H. F. SCARBOROUGH, of Poplar Bluff, Mo., has been appointed county highway engineer to succeed E. C. Nickey, resigned. Mr. Nickey held the post for eighteen years.

Commander G. A. DUNCAN, of the Civil Engineer Corps of the U. S. Navy, has been appointed engineer in chief of the Republic of Haiti. This is one of the positions to be filled by the United States under the treaty with Haiti. At the present time more than $2,000,000 is being spent annually on public works in the Haitian republic. This includes the construction of roads, sewers, telephone lines, power lines and an irrigation system. Commander Duncan came from Alexandria, La., formerly and was appointed to the Naval Academy from that state. In addition he is an alumnus of Rose Polytechnic Institute. He has just completed a tour of duty as project manager of the fleet shipbuilding and repair facilities division of the Bureau of Yards and Docks.

HOWARD H. OLDHAM has left his position with the department of sewers, Pontiac, Mich., to become assistant to the village engineer of Birmingham, Mich. Mr. Oldham is a graduate of Purdue University and previously was connected with the U. S. Steel & Tank Company, of Indiana Harbor, Ind., now the Youngstown Sheet & Tank Company.

CARL L. WILLIFORD, of Dallas, has been retained by the Texas State Highway Department as resident engineer on the proposed Northwest highway, provided for by the $6,950,000 county bond issue voted recently.

ALEXANDER T. GAMARRA, of Wellston, Ohio, has been appointed chief draftsman for the Morrow Manufacturing Company, of the same city, manufacturer of elevating and conveying equipment, coal tipples, and sand and gravel screening plants. Mr. Gamarra is a graduate of the School of Arts and Trades, Lima, Peru, and has had experience in England, Peru, Cuba and Panama. He came to the United States in 1916.

W. D. FAIRCHILD, recently engaged on the construction of Dams 47, 48 and 51 on the Ohio River for the U. S. government, is to supervise the building of the Hastings dam in the Mississippi River 25 miles south of St. Paul.

FRED F. HENSHAW, for the past eighteen years district engineer, U. S. Geological Survey, water resources branch, Portland, Ore., has been transferred to the staff of the Federal Power Commission at Washington, D. C. Mr. Henshaw has frequently acted as local representative of the Federal Power Commission in the Northwest. In 1921 he served as a member of the boards of engineers which reported on the Deschutes and Columbia rivers.

G. H. CANFIELD, who has been principal assistant in the Portland district since September, 1921, has been appointed district engineer, succeeding Mr. Henshaw. Previously Mr. Canfield had experience in hydrometric work in Utah, New York, California and southeastern Alaska.

F. H. FRANKLAND, who has been supervising structural engineer, specializing in steel work, for Dwight P. Robinson & Company, of New York, has been selected to head the engineering service bureau created by the American Institute of Steel Construction. This bureau will direct and co-ordinate the work of the ten field engineers recently appointed by the Institute. Mr. Frankland, after attending Sheffield Scientific

School of Yale University, engaged in structural engineering work in New Zealand and Australia. Later returning to the United States, he designed bridges and industrial structures in California and Louisiana. He was for four years managing engineer for Waddell & Son, New York City, and later was general manager and chief engineer in charge of design, estimating and production for the Bancroft-Jones Corporation, of Buffalo, N. Y.

WALTER C. BUETOW, of Milwaukee, has been appointed state highway engineer of Wisconsin to succeed H. J. Kuelling, resigned.

L. DUDLEY COLES has been promoted from office engineer to assistant chief engineer of the city of Newark, N. J.

Random Lines

Ashes to Ashes and Dust to Dust

By C. W.

Brooding Engineer

Bethlehem Handbook Hatchery

THE VOICE OF THE PROPHET:

Bricks will break, and rocks will fall,
Paint will peel, and concrete spall,
Wood will rot, and steel will rust,
Ashes to ashes, dust to dust.

THE CONCRETE CROWD:

Ashes to ashes and dust to dust,
Wood will rot, and steel will rust,
Bricks will break, and rocks will fall,
For permanence you need a *concrete* wall.

THE FELLOWSHIP OF FABRICATORS:

For permanence specify *structural steel;*
Timber will rot and concrete peel,
Clay bricks will fall when mortars grow faint,
Steel lasts forever with two coats of paint.

THE LADDIES OF THE LUMBER LEGION:

Wood lasts forever with two coats of paint,
And it's cheaper than steel; we'll be warped, if it ain't!
Concrete will crumble, and bricks are no good.
Ask dad how to build, and he'll say it with *wood.*

THE KLAY KILN KLAN:

Ask dad how to build, and he'll say it with *bricks!*
They'll be standing the gaff when all others are nix;
When timber and concrete and steel have gone bust,
Ashes to ashes and dust to dust.

THE PAINT PEOPLE:

Ashes to ashes and dust to dust,
Timber will rot, and steel will rust,
Bricks will break, and concrete will spall,
Save the surface and you save it all!

PROPHET AND CHORUS:

Bricks will break, and rocks will fall,
Paint will peel, and concrete spall,
Wood will rot, and steel will rust,
Ashes to ashes and dust to dust.

Engineering Societies

Calendar

Annual Meetings

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago; Annual Convention, New York, June 25-27.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, June 25-29.

AMERICAN SOCIETY OF CIVIL ENGINEERS; Annual Convention, Buffalo, N. Y., July 18-20.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Convention, Detroit, Mich., Oct. 22-28.

THE COLORADO SOCIETY OF ENGINEERS, in conjunction with the Combined Engineers of the University of Colorado, held the annual engineers' day meeting at Boulder on May 29. The chief speaker was Willard T. Chevalier, general manager of *Engineering News-Record.* Colonel Chevalier was also guest of honor at a dinner given by the Colorado Engineering Council at the Denver Athletic Club on May 28.

THE PROVIDENCE, R. I., SECTION, AM.SOC.C.E. made an inspection trip to the Mount Hope bridge the afternoon of May 22. During the evening the annual dinner and election of officers took place. C. C. Richardson was named chairman and Charles H. Dutton secretary and treasurer. The principal speaker of the evening was Harrison P. Eddy.

THE AMERICAN INSTITUTE OF QUANTITY SURVEYORS will hold its annual convention at the Hotel Pennsylvania, New York City, on June 26 and 27.

Brief News

GATINEAU POWER COMPANY, subsidiary of the International Paper Company, recently turned over the second unit of six 34,000-hp. units at its Paugan Falls plant on the Gatineau River in Quebec. Work on the four other units is proceeding, and each unit will be turned over as it is made ready.

CONSTRUCTION OF BRANCH LINES in the provinces of Saskatchewan and Alberta will be undertaken by the Canadian Pacific Railway if proper authority can be secured, according to the company's annual report. The program includes 175 miles in Saskatchewan, distributed over eight lines, and 105 miles in Alberta in four lines. The most important project in Alberta will be the extension of the Swift Current northwesterly branch from Willingdon to Edmonton, a distance of 70 miles. In Saskatchewan the outstanding work will be the extension of the Moosejaw southwesterly branch for a distance of 37 miles.

FINAL COUNT of the votes at San Francisco, May 1, on city purchase of the property of the Spring Valley Water Company for $41,000,000 showed 81,302 for and 20,852 against the proposal, while on a $24,000,000 bond issue to complete the Hetch Hetchy aqueduct the vote was 93,396 for to 11,497 against.

ENGINEERS' DAY at Ohio State University, Columbus, Ohio, was observed May 24 and 25. This event, which is fostered by the various schools of engineering at the institution, comes every two years.

A GRAIN ELEVATOR, said to be the largest in the world, is under erection at Port Arthur, Ont. It will have a capacity of 6,900,000 bu. Equipment will include eleven 150,000-lb. scales, twenty receiving cleaners, 32 other cleaners and 23 belt conveyors with a total length of more than 34,000 ft. The trackage will provide space for 225 loaded cars at one time.

Obituary

BATTLE H. KLYCE, consulting engineer, of Nashville, Tenn., a former president of the Nashville Engineering Association, died in that city on May 23 from a streptococcus infection of the leg. He was 45 years old. Mr. Klyce was one of the survivors of the "Norman" disaster of three years ago, and at that time injured his leg at the same place at which the infection started, but physicians say that the injury was not the cause of the infection. Mr. Klyce formerly resided in Miami, Fla., and while there, in conjunction with W. J. Kackley, he built the causeway that spans the bay. He returned to Nashville in 1917 and was named as assistant city engineer to W. H. Kirkpatrick for the city of Jackson, Miss., and succeeded Mr. Kirkpatrick as engineer when the latter lost his life in the "Norman" disaster.

IRVING WORTHINGTON, one of the pioneer surveyors of the West, died at his home in Spokane, Wash., on May 27 at the age of 60. Mr. Worthington, a member Am.Soc.C.E., was appraisal engineer for the Federal Land Bank at Spokane.

JOHN HENRY CUNTZ, age 61, died May 29 at Hoboken, N. J. A graduate of Rensselaer Polytechnic Institute and Stevens Institute as civil, mechanical and electrical engineer, Mr. Cuntz had worked for Thomas A. Edison, the U. S. Coast and Geodetic Survey, and was later engaged in research in wireless and cable construction.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Specifications Index

The Bureau of Standards has announced the publication of an "Alphabetical Index and Numerical List of the U. S. Government Master Specifications" promulgated by the Federal Specifications Board and complete to Jan. 1, 1928. Copies may be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C. In ordering, specify Bureau of Standards Circular No. 319.

Business Notes

ELECTRO BLEACHING GAS CO., New York City, announces the advancement of S. W. Jacobs to the position of vice-president.

MORRISON RAILWAY SUPPLY CORPORATION, Buffalo, has purchased the railway track material business formerly conducted by Morrison & Risman, Inc., which was established over 40 years ago.

GEORGE HAISS MFG. CO. INC., New York City, announces the appointment of the following new distributors: Edelen & Boyer Co., Phila., Pa.; Alamo Iron Works, San Antonio, Texas; Choctaw Culver & Mchy. Co., Memphis, Tenn., and D. T. Hastings, Ware, Mass.

EDWIN B. POTTS, formerly sales manager of the C. F. Seabrook Co. Inc., New York City, and H. P. Low, a recent representative of that company, have incorporated the North Jersey Tractor Co., and in addition to promoting the sale of Caterpillar tractors, will represent the manufacturers of a full line of tractor equipment. An office and warehouse has been established at Garwood, N. J.

LINDE AIR PRODUCTS CO., New York City, announces the opening of a new district sales office in Memphis, Tenn., with H. M. Smith in charge.

ANCHOR POST FENCE CO., Baltimore, Md., announces that W. F. Brannan has been elected president to succeed the late Herbert G. Thomson.

F. A. ERNST has been appointed assistant district sales manager of the Inland Steel Company's St. Louis office, succeeding W. F. Brumm, who was advanced to the district sales managership of the office last August.

ALEXANDER MILBURN COMPANY, Baltimore, announces that B. R. Sausen has been placed in charge of its paint spray equipment department. Mr. Sausen gained his mechanical experience with the Westinghouse Electric & Manufacturing Company and has recently been general sales manager of the Binks Company, selling paint spray equipment.

TIMKEN ROLLER BEARING SERVICE COMPANY, Canton, Ohio, announces the appointment of W. H. Post as manager of its Pittsburgh office. Mr. Post has been with the company for several years in sales work in the Cleveland district.

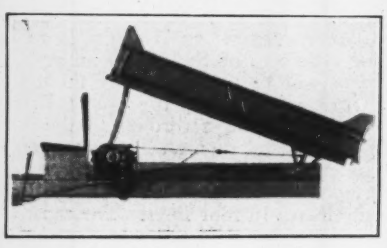
J. H. BRILLHART, formerly vice-president of the Fort Worth Steel & Machinery Company, Fort Worth, Tex., has resigned his position with that company and, with others, has organized the Fort Worth Structural Steel Company, of which he is the president. The new company has taken over by lease the structural steel and tank department of the Fort Worth Steel & Machinery Company. Mr. Brillhart is a graduate of Lehigh University, and before becoming connected with the Fort Worth company was chief engineer for the Gerber Engineering Company, Bethlehem, Pa., from 1906 to 1912 and chief engineer and consulting engineer for the Mosher Manufacturing Company, Dallas and Houston, from 1912 to 1922.

New Developments

New Dump Body Hoist of Novel Design

A power-operated dump body hoist which has recently been placed on the market by Ditwiler Manufacturing Company, Galion, Ohio, utilizes as its hoisting member an articulated rack with teeth which mesh into the final spur-gear drive. The rack consists of 23 sections held together by $\frac{5}{8}$-in. pins with riveted heads. As the body is lowered the extra length of the rack curves back into a dust-tight case. In this direction the rack is very flexible but when in hoisting position (slightly curved) it is rigid. It is claimed to be strong enough to carry twice the load that will be necessary in light or medium truck service.

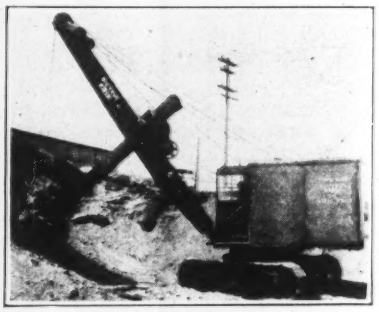
The hoist may be stopped at any position, and automatic cutoffs are provided to stop motion at the highest angle, 55 deg., and at the lowered position. The body can be operated while the truck is in motion. Alloy steel parts, machine-cut gears operating in oil, bronze bushings and ball bearings are used throughout. Double-bevel gears and worm gearing are used in the power transmission unit.



According to the manufacturer, the center of the front of a truck body is the most efficient point for easy lifting. This new hoist is attached at this point and is claimed to require only about 5 per cent of the power available at the takeoff from the transmission of the engine. The hoist is operated entirely from the cab. It is being marketed by Hercules Products, Inc., Evansville, Ind., and its distributors throughout the United States.

Larger Engine for New Power Shovel in $\frac{3}{4}$-Yd. Class

A 72½-hp. gasoline engine is used with the new gasoline shovel and crane, type "1030," recently placed in quantity production by the Bucyrus-Erie Company, Milwaukee, Wis. Greater power and speed, both in swinging and hoisting, are claimed as a result of the new power unit. Such additional power is of unusual advantage in hard digging and



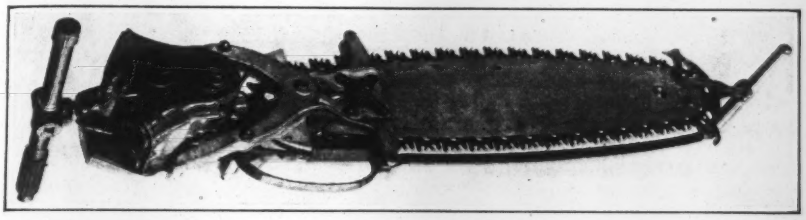
increases quantity output in light material handling.

Oversize contracting-band clutches are used, with a contracting shoe brake to stop the swing. To prevent the swing gears from working apart and springing the shafts, these gears are tied together and held in positive alignment by a steel box housing. The drum shaft is 5½ in. in diameter and the swing clutch shaft is 3⅝ in. in diameter. Other parts in the machine are in proportionate sizes. The truck frame is a one-piece steel casting, as is also the revolving turntable, providing a rigid base for the operating machinery and cutting down vibration to a minimum. Every running shaft above deck which operates while the machine is digging is equipped with self-aligning ball bearings. Perfect alignment is said to be insured by the use of only two bearings on each shaft. All high-speed gears are inclosed and run in a bath of oil, as do the driving gears of the crawler mounting. An added feature is the fact that the weight of the machinery is placed entirely to the rear of the center pin,

giving the machine an extra margin of counterbalance for heavy lifting when operating as a crane. It is also claimed that this feature adds stability when the machine is used as a shovel.

Timber-Sawing Machines Now Equipped With Air Motor

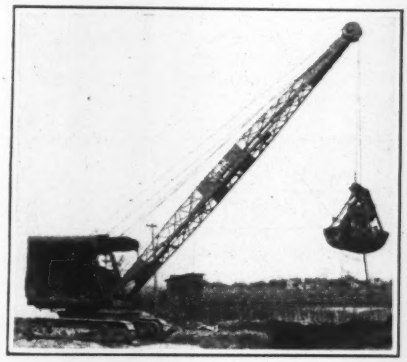
To satisfy the demands of contractors and railroads, the Wolf portable timber-sawing machine, brought out last year by the Reed-Prentice Corporation, of Worcester, Mass., is now equipped with



Type A Ingersoll-Rand air motor. The air-operated machine is identical in design, except for power, with the original electrically driven machine and compares with it in every way in operation. The machine, weighing 95 lb., uses 70 cu.ft. of air per minute at 80 lb. and has a capacity for sawing 24-in. timbers.

New Gasoline Shovel Added to Bay City Line

A sturdy compact ¾-yd. full-revolving convertible shovel, crane or ditcher, has



been announced by the Bay City Dredge Works as the Bay City Model R. Following are the convertible attachments of this new machine: (*a*) Standard ¾-yd. shovel dipper; (*b*) all manganese rock dipper, ⅝-cu.yd. capacity; (*c*) crane boom in 35-, 40- or 45-ft. lengths to handle loads up to 10 tons and ½- to 1-cu.yd. clamshells or ¾- to 1-cu.yd. draglines; (*d*) trench boom and scoop with trencher buckets ranging from 18 to 42 in. in width with a maximum digging depth of 20 ft.

The machine is powered by a four-cylinder 5½x7-in. Climax engine developing 62 hp., or can be furnished with electric power if desired. Timken roller bearings are used on all high-speed shafts. Steering is controlled by the operator from the cab without leaving his lever position or making any changes in the propelling mechanism. Unusual stability is secured by the use of a 6½-ft. diameter revolving table, and by placing the boom base only 30 in. from the center pin. This latter feature permits the lifting of heavier loads than is ordinarily possible.

New Publications

Cement—ALPHA PORTLAND CEMENT COMPANY, Easton, Pa., has published a 112-page handbook, entitled "Alpha Cement—How to Use It." The handbook gives much practical and valuable information in regard to the construction of concrete structures. Typical sections of the handbook consider the following: Forms and reinforcement for concrete; concreting in cold weather; cement houses; cement posts; walks and floors; curves and driveways. The handbook is planned for the builder of small structures.

Electric Motors—LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, has published a 26-page catalog devoted to its electric motors. These motors are fabricated largely by means of electric welding. The catalog besides including full descriptions of the motors is devoted largely to the manufacturing methods and the many claimed advantages that electric arc welding contributes to motor manufacture.

Form Ties and Shores—DAYTON SURE-GRIP & SHORE COMPANY, Dayton, Ohio, has published a new booklet in which are described adjustable shores, form ties and spreaders, furring clips and its concrete inserts capable of carrying a 4-ton load. Diagrams showing the method of application of the various products form a part of the information.

Pneumatic Tools—CHICAGO PNEUMATIC TOOL COMPANY, New York City, has recently published catalog No. 561 devoting 70 pages to its pneumatic tools and accessories. Illustrations, descriptions and size and capacity tables are given for each of the products. Included among the tools and accessories described are riveting hammers, rivet cutters and busters, stationary riveters, chipping hammers, scaling tools, clay diggers, floor rammers and backfill tampers, air drills, grinders, hoists and rock drills.

Copper Steel—AMERICAN SHEET AND TIN PLATE COMPANY, Pittsburgh, has issued a new bulletin entitled "Anti-Corrosive Metals" in which it compares its copper steel with other types of steel and iron. The use of copper steel in culverts, tanks and other sheet work is pointed out.

Manufacturers and Trade Associations

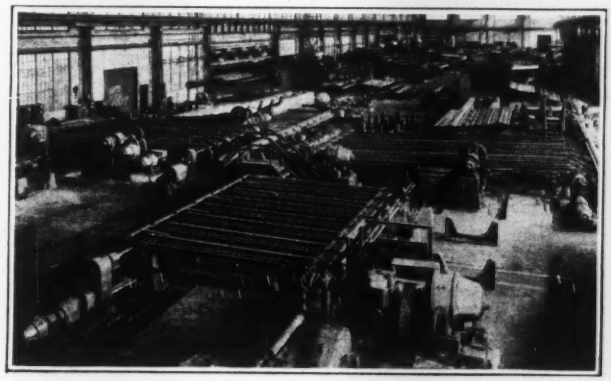
Calendar

Annual Meetings

AMERICAN WATERWORKS MANUFACTURERS ASSOCIATION, New York City; annual meeting, San Francisco, Calif., June 11-14.

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

NEW BETHLEHEM PIPE MILLS AT SPARROWS POINT, MD.



Interior and exterior views of the Bethlehem Steel Company's new mills for the manufacture of butt-welded pipe, ⅛ to 3 in. in diameter, lap-welded pipe, 2 to 16 in. in diameter, and all auxiliry materials. A galvanizing department and a warehouse 640 ft. long by 110 ft. wide complete the units in this new self-contained plant.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Middle Atlantic Leads Country in Increased Construction Activity

1928 Continues to Show 25 Per Cent Greater Contract Volume Than First Five Months of 1927

TOTAL contract awards during the five weeks of May, 1928, were $357,059,000, or $54,331,000 more than during the preceding month. On the basis of average weekly lettings the construction industry showed the same activity as in May, 1927, and was about 5.6 per cent lower than in April of this year. The value of contracts awarded this year to date, however, is still 25 per cent ahead of last year.

The Middle Atlantic states lead in the percentage increase over the first five months of 1927. This year contracts exceeded those of a year ago in this section by 66 per cent. The South showed a substantial increase of 31 per cent; New England, 18; Middle West, 14, and Far West 2 per cent above a year ago. The Far West showed the only decline. Contracts were 12 per cent lower than last year for that section.

All classes of construction showed larger five-month totals in 1928 except sewers, excavations, federal government and private unclassified work. The outstanding increases in awards were made in streets and roads (62 per cent) and in private commercial buildings (33 per cent). This year is 26 per cent ahead of last for all private construction and public awards are 23 per cent greater than in 1927.

Commercial buildings constitute the largest class of construction as measured by value of contracts; the section in which the greatest expenditures for all construction are made is the Middle Atlantic. Average monthly awards for private commercial buildings in this section in 1928 has been $71,461,000, while the average month for all 1927 was $44,380,000. There is, however, no indication or suggestion of overconstruction in this increasing rapidity with which these large commercial buildings, both residential and commercial, are being built. Rents have been practically unchanged in New York City within the last three years, and there was a continual increase in rents since 1915. Average rents for the whole country have been declining since the high point reached in December, 1924.

Compared with average weekly contract awards in April, 1928, May showed an increase in only one section, New England. Two exceptionally large waterworks contracts in Massachusetts which contributed to the total. Very small decreases were shown in the Middle West and West of the Mississippi.

Classes of construction for which contract values exceeded the weekly rate a month ago were: water-works, bridges, excavations, industrial buildings and federal government work. Two conspicuous bridge awards were the Lake Champlain bridge from Crown Point, N. Y., to Chimney Rock, Vt., and a railroad bridge over Newark Bay. The contract value for the former was $920,177 and the total value of the latter structure will be $7,500,000.

Business Conditions Characterized by Contradictory Movements

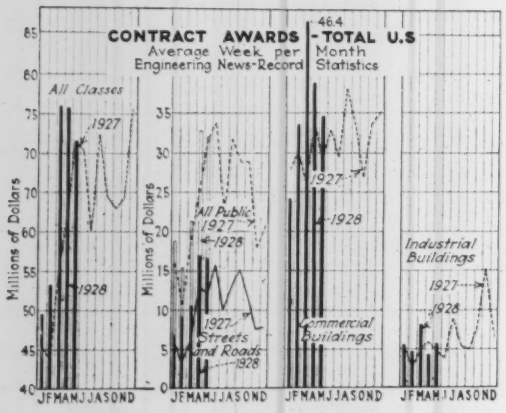
Compared with last year, economic data indicating a more favorable business situation include greater production in the iron and steel and automotive industries, fewer business failures, more electric power consumed by all industries, higher bank debit totals outside New York City and increased prices for commodities at wholesale. Among unfavorable factors are the small volume of freight loadings, lower indexes of payrolls and employment and higher money rates.

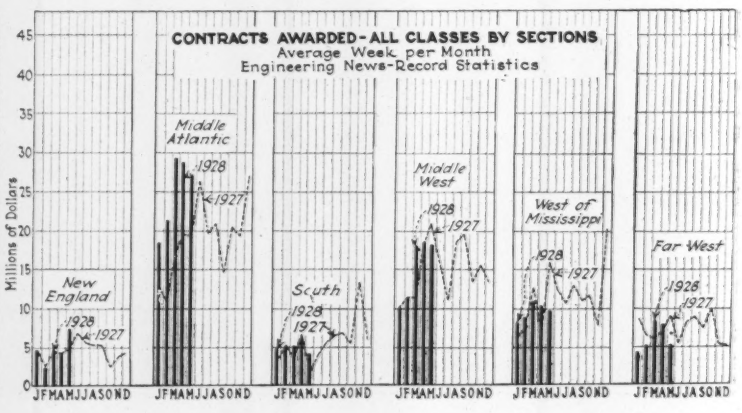
A noticeable increase in the wholesale price index of the Bureau of Labor Statistics was shown in April. The March price index, based on 550 commodities, was 96.0 and in April it was 97.4. Two groups, textile products and

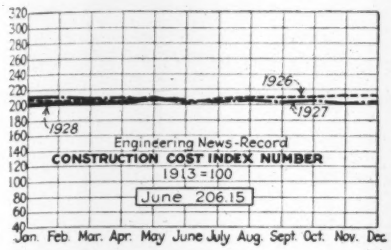
VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA—MAY 1, 1928

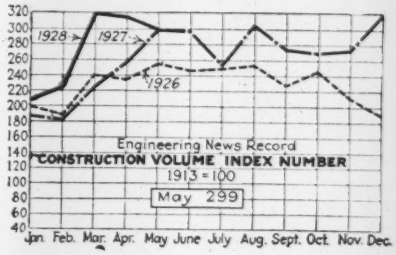
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to date, U. S.	Canada
Waterworks	$8,964	$1,342	$239	$510	$859	$1,691	$13,605	$24,519	$23
Sewers	119	1,218	384	6,183	1,077	1,350	10,331	38,837	497
Bridge	805	10,573	1,884	4,053	2,340	984	20,639	58,560	375
Excavations, drainage, etc	70	353	324	664	122	.....	2,133	7,353	.....
Streets and roads	3,655	22,974	8,539	28,351	12,997	6,903	83,419	265,279	1,833
Industrial buildings	7,057	6,349	2,690	5,254	5,246	1,173	27,769	124,693	2,200
Commercial buildings	15,259	78,337	5,625	42,574	19,195	12,669	173,659	791,526	6,704
Federal government	271	935	493	129	1,781	437	4,046	19,371	.....
Unclassified	703	12,815	267	1,819	4,699	1,155	15,458	120,444	1,697
May, 1928	36,903	134,896	20,445	89,537	48,916	26,362	357,059	.....	13,329
April, 1928	17,018	114,380	24,780	73,765	41,813	30,972	302,728	.....	.....
May, 1927	19,268	77,056	7,352	82,547	63,239	35,818	285,280	.....	.....
Year to date, 1928	102,471	552,507	109,729	338,891	211,169	135,815	.....	1,450,582	64,051
Year to date, 1927	86,538	332,644	83,740	297,910	207,920	153,799	1,162,551	.....	37,592









ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

fuel and lighting, showed no change from the preceding month, and the only groups which decreased were house-furnishings and miscellaneous. The greatest increase was shown in farm products and hides and leather products. The building materials group increased to 92.5 from 91.0.

Productive activity for all industries in April showed an increase over the preceding month, and each month of 1928 has exceeded the corresponding month of last year, according to the index based on electric power consumption compiled by the *Electrical World*. The power consumption in the automotive industry increased more noticeably than the general index and was the same as the high February figure. The textile industry as measured by this index showed decreasing activity during March and April.

Actual automobile production in April totaled 410,000 cars—a decrease of 6,508 passenger cars and an increase of 3,500 trucks. Compared with April, 1927, truck production decreased slightly and there was an increase of 2 per cent in passenger car production. The latest figures available for car registrations show the total for the first quarter of 1928 to be about 7.5 per cent lower than a year ago.

Coal production during 1928 up to May 19 totaled 184,900,000 net tons, about 42,000,000 tons less than last year. April coal consumption in the United States and Canada was 8¾ per cent lower than last year.

March exports of cement were larger than those of January or February, 1928, and March, 1927. Imports showed a moderate upward trend throughout 1927 and this year to date.

Bank debits outside New York City have had an upward trend since a low point the last of February, 1928. April and May debits have indicated greater business activity and more favorable trade than a year ago.

Each successive week since April 14 has shown increases in freight loadings. The weeks ended May 12 and May 19 exceeded a million cars. The chart on this page shows this year's loadings to have continued lower than 1927.

The payroll and employment indexes of the Bureau of Labor for April, 1928, showed slight decreases from March figures. Both indexes are lower for the four months of 1928 than in the corresponding period a year ago.

Business failures during the week ended June 2 totaled 344, compared with 370 in the corresponding week last year. The main reduction in the number of failures was in the South, and this reduction offset increases in the East and Pacific Coast states.

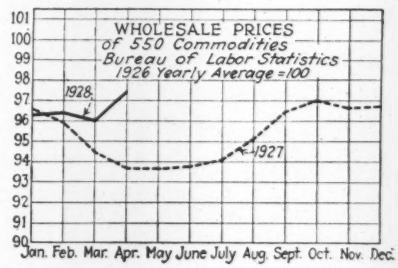
On June 4 the call loan renewal rate reached 7 per cent, which was the highest rate since June, 1921. The average daily rate has been 6 per cent since May 18, but it was 6½ per cent on May 28. The average price of 40 bonds as compiled by Dow, Jones & Company has marked a downward trend since the first part of January. The highest point this year was 99.48 on Ja... 13, and on June 2 a low price of 98.03 was reached. The stock market has continued its high activity throughout May. The average price of twenty industrials was higher than in any preceding month. The lowest daily price was $211.73 on May 22 and the highest, on May 14, was $220.88.

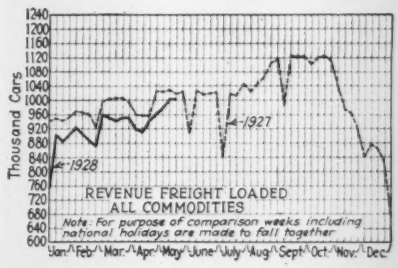
Volume Index Same as Year Ago; Change in Cost Negligible

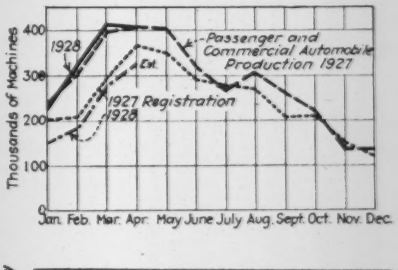
Slight fluctuations in steel and lumber prices and wages of common laborers caused a decline of 0.85 point in the *Engineering News-Record* Construction Cost Index Number, compared with the May 1 value. The June 1 figure is 206.15.

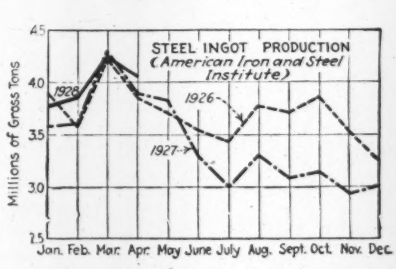
The *E. N.-R.* Construction Volume Index Number for May, 1928, is the same as for May, 1927. In noting the decline from the April figure, it must be taken into account that the latter is the third highest on record. The latest figures, with comparisons, are given below:

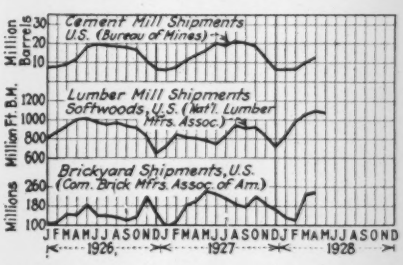
E. N.-R. Cost Index		E. N.-R. Volume Index	
June, 1928	**206.15**	**May, 1928**	**299**
May, 1928	207.00	April, 1928	316
June, 1927	205.55	May, 1927	299
Peak June, 1920	273.80	1927 (average)	263
1927 (average)	206.24	1926 (average)	228
1913 (average)	100.00		
1927		1927	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316

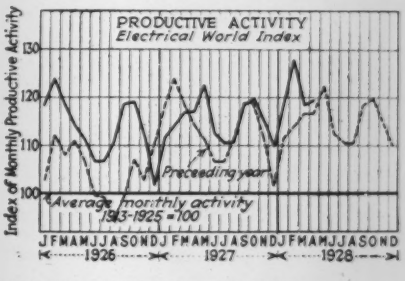

WHOLESALE PRICES
of 550 Commodities
Bureau of Labor Statistics
1926 Yearly Average = 100
1928
1927
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


Thousand Cars
1927
1928
REVENUE FREIGHT LOADED
ALL COMMODITIES
Note: For purpose of comparison weeks including national holidays are made to fall together
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.






Cement Mill Shipments U.S. (Bureau of Mines)
Million Barrels
Lumber Mill Shipments Softwoods, U.S. (Nat'l. Lumber Mfrs. Assoc.)
Million Ft. B.M.
Brickyard Shipments, U.S. (Com. Brick Mfrs. Assoc. of Am.)
Millions
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


PRODUCTIVE ACTIVITY
Electrical World Index
Index of Monthly Productive Activity
Preceding year
Average monthly activity 1913-1925 = 100
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928

STEEL AND AUTOMOTIVE PRODUCTION—ELECTRICAL ENERGY CONSUMED—FREIGHT LOADINGS

Building Materials Tend Higher Under Heavy Demand

Prices of the principal building materials have moved gradually upward since the first of the year. This is in direct contrast to the direction taken during the corresponding period of 1927 and also of 1926. Contract figures given on p. 912 of this issue indicate the extent of the present record demand for engineering construction. This is the principal reason for the higher prices. Cement and paint materials are the only important exceptions to the rising tendency.

So slight is the year-to-year fluctuation in the national average of cement quotations that for stability, cement prices are to be compared with those of steel rails, wrought pipe or tin plates. Cement mills of the country, in the first four months of 1928, produced more, shipped less, and, as a consequence, had heavier reserve stocks on hand, than during the corresponding period last year. This statistical position, if maintained, should exert a downward pressure on prices. Figures from the Bureau of Mines are as follows:

BARRELS IN FIRST FOUR MONTHS

	1928	1927	Per Cent Change From 1927
Production...	42,256,000	41,134,000	+ 3
Shipments ...	36,546,000	38,149,000	— 4
Stocks, May 1	27,605,000	23,654,000	+17

The present upward movement in linseed oil serves to offset the recent downward trend in red and white lead. The latter is the result of present large stocks of pig lead. There have, therefore, been no changes in the prices of mixed paints.

Steel shapes registered an average month-to-month rise of 2 per cent throughout the first quarter of 1928. Second-quarter prices range from $1.85 to $1.90 per 100 lb., f.o.b. Pittsburgh. Although shapes and plates are now selling at $1.85 for large mill lots, $1.90 is asked on all third-quarter deliveries. A year ago the quotation was $1.80 to $1.90. Ingot output for the four months of 1928 was 16,846,729 tons, which compares favorably with 16,264,527 tons for the same period last year.

Lumber, while it slumped in April, showed steady price gains throughout May over the entire country. Douglas fir prices advanced owing to curtailment of output in Pacific Coast mills. Active buying of yellow pine in Southern markets has greatly strengthened the prices for that species. Stocks in Mid-Western yards are below normal for the season. The long-range trend of lumber prices, however, is down. More softwood lumber has been cut, sold and shipped thus far in 1928 than during the corresponding part of 1927. Sales are sufficiently ahead of the cut to prevent abrupt price declines.

Average brick prices rose slightly in April, and continued upward in May. This movement is purely seasonal, since the long-range price trend is down. Demand is active in all sections of the country except the Middle West, which is the heaviest brick-consuming region of the United States. Oversupply has prevented price advances.

The most important May price advances are for the following materials: Reinforcing bars, 10c. per 100 lb. at Pittsburgh; cast-iron pipe, $1 per ton in Chicago and San Francisco, $2 in Pittsburgh and St. Louis; wrought-steel pipe discounts down three points at New York warehouse; common lump lime, 25c. per barrel in Boston and $3 per ton in Montreal; asphalt, $3 per ton, Kansas City; ship spikes, 25c. per 100 lb. San Francisco; pine timbers, $1, and fir, 50c. per 1,000 ft. at Chicago.

Declines occurred as follows: Blue annealed and galvanized sheets, 10c. per 100 lb., Pittsburgh; manila rope, 2c. per pound, San Francisco; dynamite, ½c. per pound, Minneapolis and Denver; wood blocks, 5c. per square yard at Boston and 10c. in St. Louis.

Record Employment at Ford's Plants—Conditions Elsewhere

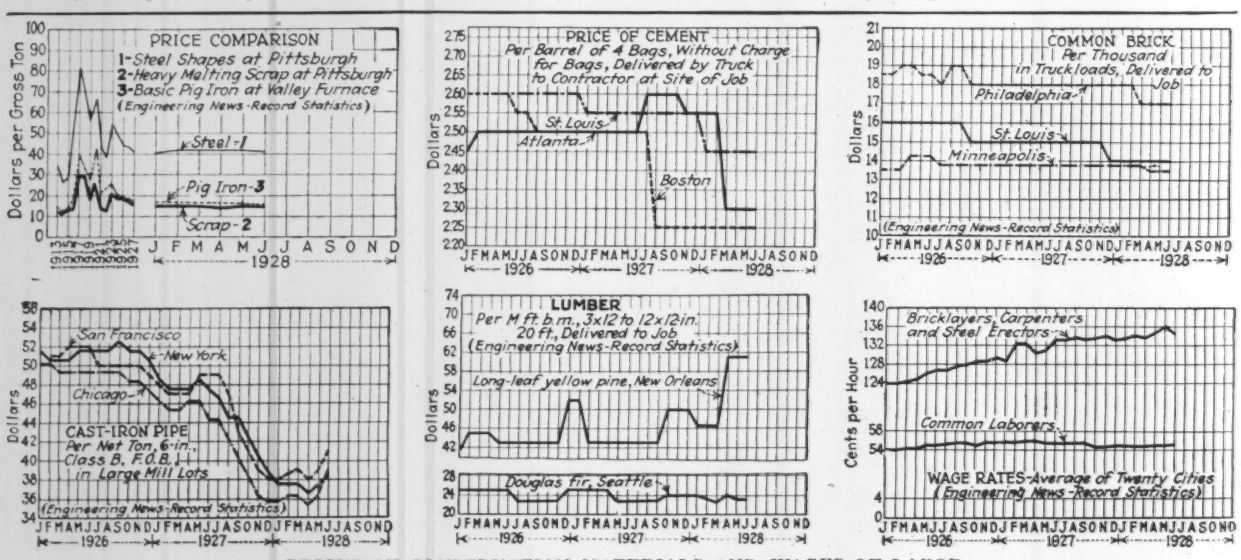
Plants of the Ford Motor Company at Detroit recorded an employment record in the week of May 31, when there were 115,395 persons on the payroll. The previous record was made in the week preceding, with 112,683 employees, and the one before that was in the summer of 1926, with 110,000. Ford's plant operations, however, are not regarded as being indicative of general labor conditions. The steel industry, an important indicator of general conditions, is operating at an average of 80 per cent of mill capacity as against 82 per cent the week before and 80 per cent a year ago.

Industries reporting increased employment of factory labor are iron and steel products, lumber, non-ferrous metals, stone, clay, glass, automobiles and other vehicles. Those showing marked decreases are food products, textiles, leather, chemicals, tobacco, paper and printing.

Wage cuts are occurring with greater frequency than increases. This is particularly true of the textile industry, where a 10 per cent reduction recently became effective at New Bedford mills. Gradually declining rents and retail food prices serve as balancing factors in the present downward trend of factory wages.

Unemployment among members of the American Federation of Labor represented 16 per cent of total membership in 24 cities in April, as against 18 per cent during March, 1928. Increased idleness is reported in Jersey City, Philadelphia, Birmingham and San Antonio. Conditions are unchanged in Chicago, Cincinnati, Los Angeles, Milwaukee and St. Louis. In the fifteen remaining cities there was increased employment of A. F. of L. members.

The total number of strikes in all industries is 34 per cent greater than a year ago.


PRICE COMPARISON
1-Steel Shapes at Pittsburgh
2-Heavy Melting Scrap at Pittsburgh
3-Basic Pig Iron at Valley Furnace
(Engineering News-Record Statistics)
Dollars per Gross Ton
Steel-1
Pig Iron-3
Scrap-2
J F M A M J J A S O N D
1928
PRICE OF CEMENT
Per Barrel of 4 Bags, Without Charge for Bags, Delivered by Truck to Contractor at Site of Job
Dollars
St. Louis
Atlanta
Boston
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
COMMON BRICK
Per Thousand in Truckloads, Delivered to Job
Philadelphia
St. Louis
Minneapolis
(Engineering News-Record Statistics)
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
CAST-IRON PIPE
Per Net Ton, 6-in., Class B, F.O.B. in Large Mill Lots
San Francisco
New York
Chicago
(Engineering News-Record Statistics)
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
LUMBER
Per M ft. b.m., 3x12 to 12x12 in. 20 ft., Delivered to Job
(Engineering News-Record Statistics)
Long-leaf yellow pine, New Orleans
Douglas fir, Seattle
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
WAGE RATES-Average of Twenty Cities
(Engineering News-Record Statistics)
Bricklayers, Carpenters and Steel Erectors
Common Laborers
Cents per Hour
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928

PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern (silicon 2.25@2.75)	$19.69
Northern Basic	20.89
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19
NEW YORK, tidewater delivery	
Southern No. 2 (silicon 2.25@2.75)	25.62
BIRMINGHAM	
No. 2 Foundry (silicon 2.25@2.75)	16.00
PHILADELPHIA	
Eastern Pa., No. 2X (silicon 2.25@2.75)	21.76
Virginia No. 2 (silicon 2.25@2.75)	27.17
Basic	21.26
CHICAGO	
No. 2 Foundry Local (silicon 1.75@2.25)	20.00
No. 2 Foundry Southern (silicon 2.25@2.75)	*22.01*
PITTSBURGH, including freight charge ($1.76) from the Valley	
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26
Basic	19.26
Bessemer	21.26

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Birmingham Per Gross Ton
No. 1 railroad wrought	$10.00@$10.50	$13.00@$13.50	$11.00@$11.50
Stove plate	*7.25@ 7.50*	13.00@ 13.50	9.00@ 9.50
No. 1 machinery cast	12.50@ 14.00	15.00@ 15.50	12.50@ 14.00
Machine shop turnings	*6.25@ 7.25*	7.00@ 7.50	7.00@ 7.25
Cast borings	6.25@ 7.25	9.25@ 9.75	7.25@ 7.50
Railroad malleable	10.00	12.75@ 13.25	10.25@ 10.75
Re-rolling rails	10.00@ 10.50	14.50@ 15.00	10.25@ 10.75
Re-laying rails	23.00@ 24.00	.....	23.00@ 24.00
Heavy melting steel	6.75@ 10.75	12.75@ 13.25	.....
Iron and steel pipe	8.25@ **8.75**	.....	.....

Railway Supplies

STEEL RAILS—Per gross ton f.o.b. for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00
Light rails, 25 to 45 lb.	36.00	34@36	36@38
Re-rolled rails	*30.00*	34@36	

RAILWAY TIES—For fair-sized orders, f. o. b., the following prices per tie hold:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	Southern pine untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
St. Louis	White Oak, untreated	*1.15*	*1.40*
	Red oak, creosoted	*1.45*	*1.90*
Chicago	White oak, heart, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southernpine, creosoted	1.60	2.10
San Francisco	Douglas fir, green, untreated	.....	1.14
	Douglas fir, empty cell, creosoted	1.78	2.32

TRACK SUPPLIES—Per 100 lb. f.o.b. Pittsburgh mill for large mill lots together with warehouse prices at other places named:

	Pittsburgh	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, $\frac{9}{16}$-in. and larger	$2.80	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	4.55	4.65	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	3.40	4.25	4.25	3.00
Tie plates	2.15	2.15*	2.58	.....	.....

*At Chicago mills in carloads.

Pipe

WROUGHT STEEL AND IRON PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1½	60	49½	1 to 1¼	30	14
2 to 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—On deliveries from warehouses at the places named the following discounts from list hold for standard steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	50%	54%	49%
2½ to 6 in. lap welded	45%	51%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	36%	41%	36%
2½ to 6 in. lap welded	32%	38%	33%

WROUGHT STEEL PIPE LIST

Size, Inches	List Price per Foot	Diameter in Inches—External	Diameter in Inches—Internal	Thickness Inches
⅛	$0.17	0.405	0.269	.068
¼	.23	0.54	0.364	.088
⅜	.27½	0.675	0.493	.091
½	.37	0.840	0.622	.109
¾	.58½	1.050	0.824	.113
1	.92	1.315	1.049	.133
1¼	1.09	1.66	1.38	.14
1½	1.27	1.9	1.61	.145
2	1.48	2.375	2.067	.154
2½	1.92	2.875	2.469	.203
3	2.38	3.5	3.068	.216
3½	2.50	4.0	3.548	.226
4	2.88	4.5	4.026	.237
4½	3.45	5.0	4.506	.247
5	3.20	5.563	5.047	.258
6	3.50	6.625	6.065	.28
7	4.12	7.625	7.023	.301
8	4.63	8.625	8.071	.277
8	4.50	8.625	7.981	.322
9	5.07	9.625	8.941	.342
10	5.47	10.750	10.192	.279
10	6.41	10.750	10.136	.307
10	7.08	10.750	10.020	.365
11	7.58	11.750	11.000	.375
12	7.85	12.750	12.090	.330
12	8.44	12.750	12.000	.375

CAST-IRON PIPE—Prices per net ton for bell and spigot pipe, Class B and heavier, f. o b., in large mill lots:

	Birmingham	Burlington, N. J.	New York
4 in.	**$31.00**	$39.00	**$41.60**
6 in. and over	**34.00**	36.00	38.60

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	**$42.50**	**$42.20@$44.20**	**$39.60**	**$44.00**
6 in. and over	**39.50**	**39.20@41.20**	**36.60**	**41.00**

Gas pipe and Class "A," $3.00 per ton extra.

CLAY DRAIN TILE—Prices are delivered per 1,000 lin.ft.:

Size, In.	New York	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$50.00	$45.00	.....	.....
4	56.00	50.00	56.00	*$67.50*	$73.00
5	.....	.....	80.00	*86.25*	110.00
6	90.00	85.00	105.00	*112.50*	118.00
8	150.00	195.00	175.00	*187.50*	150.00

SEWER PIPE—Prices are delivered in cents per foot for standard pipe; 6, 8 and 12-in. single strength and 18, 24, 30 and 36-in. double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	**$0.20**	**$0.34**	**$0.75**	.....	**$2.00**	.....	.....
Baltimore	.....	.24	.46	.....	1.53	.....	$6.50
Birmingham	.135	.2215	.4015	$1.4625	2.665	$3.96	5.06
Boston	**.15**	**.27**	**.51**	.....	**1.85**	.....	5.50
Cincinnati	.....	**.245**	**.4725**	.....	**1.575**	.....	4.8175
Chicago	.16	.28	.54	1.25	2.25	.....	.....
Dallas	.35	.50	.90	1.70	3.00	.....	.....
Denver (f.o.b.)	.185	**.27**	.47	1.35	**1.70**	.....	.....
Detroit (f.o.b.)	.18	.28	.6075	**1.50**	2.70	.....	.....
Kansas City	.21	**.29**	.52	.....	1.90	.....	3.80
Los Angeles	.21	.27	.486	.....	1.74	.....	.....
Montreal	.....	.45	.75	.....	2.60	.....	.....
Minneapolis (f.o.b.)	.1575	.25	.45	**1.05**	1.80	3.75	4.94
New Orleans	.195	.325	.5525	1.105	2.112	.....	.....
New York	.22	.35	.61	1.50	2.70	5.12	7.91
Philadelphia (f.o.b.)	.....	.182	.351	.....	1.215	.....	4.6125
Pittsburgh (f.o.b.)	.1035	.161	.3105	.90	1.62	3.024	4.8175
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.32	2.16	3.60	.....
Seattle	.14	.22	.54	1.26	2.16	3.60	.....

Road and Paving Materials

ROAD OILS—Price per gal. in tank cars, 8,000 gal. minimum, f.o.b., at places named:

New York, 40@50% asphalt	(at terminal)	$0.0725 @$0.075
New York, 50@60% asphalt	(at terminal)	.0675 @ .072
St. Louis, 40@50% asphalt		*.0418*
St. Louis, 50@60% asphalt		*.0428*
Birmingham, 40@50% asphalt		.0525
Birmingham, 50@60% asphalt		.0475
Dallas, 40@50% asphalt		.06
Dallas, 50@60% asphalt		.061

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (Texas)	$24.50	.....
Boston (Mexican)	24.00	$19.00
Chicago (Texas)	24.50	21.30
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Dallas (Texas)	26.00	.....
Seattle, ("D" grade, California, f.o.b. Richmond refinery)	19.50	13.50
Denver (California)	35.00	.....
Minneapolis, (Stanolind, f.o.b. Twin Cities)	28.10	22.10
St. Louis (Mexican)	23.50	19.50
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Montreal (Imperial)	28.00	21.50
Atlanta (Mexican)	23.60	19.40
Detroit (Mexican)	24.00	19.00
Cincinnati (Kentucky Rock)	.....	11.65
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	23.00	.....
Philadelpria (Mexican)	20.00	18.00
Kansas City, Mo. (Texas)	27.30	**25.30**
Los Angeles ("D" Grade, California, f.o.b. El Segundo)	18.00	12.00
Birmingham (Mexican)	27.00	21.00
New Orleans (Mexican)	20.00	17.00

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton. Drums used in New York.

PAVING STONE—Prices, f.o.b., in carloads or cargo lots:

New York (grade I)	granite, 5-in., 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	Granite, 5-in.	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	Granite, 5-in.	3.00 per sq.yd.
Baltimore	Granite	3.00 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	110.00 per M.
St. Louis	Granite	3.35@**3.65** per sq.yd.
Kansas City	Granite	**3.75** per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—Prices in fair-sized quantities, alongside dock:

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra.

St. Louis: Class "B" straight, delivered, 5x16 in., 85c. per lin.ft.; roundings, $1.16@$1.41 per lin.ft.

Birmingham: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft.

WOOD-BLOCK PAVING—Prices f.o.b. in carloads:

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	5½	16	2.70
Boston	3½	18	*2.50*
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	*2.15*
St. Louis	4	16	2.50
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50

Construction Materials

SAND AND GRAVEL—Prices are per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel 1½ In.	Gravel ¾ In.	Sand
New York	$3.25@$3.50	$3.25@$3.50	$2.00@$2.25
Denver (2,700)	1.50	1.50	1.50
Chicago	**2.10@2.25**	**2.10@2.25**	**2.10@2.25**
St. Louis, per ton	1.45	1.45	1.20@1.45
Seattle (3,200) (2,850)	1.00	1.00	1.00
Dallas	2.50	2.50	2.25@**3.00**
Minneapolis (2,800)	2.25 ton	2.25 ton	1.00
Cincinnati, per ton	1.90	1.60	1.60
San Francisco (bunkers) (2,800)	1.80	1.80	1.40
Boston, per ton	1.90	1.90	1.35
New Orleans (2,700) (2,500)	*2.50*	*2.50*	1.50
Los Angeles, per ton, f.o.b.	1.80	1.80	1.30
Atlanta, per ton	3.00	3.00	2.25
Detroit (2,600)	3.00	3.00	2.50
Baltimore	2.40	2.60	1.70
Montreal, per ton	1.90	1.50	1.20
Birmingham (2,600)			2.65
Philadelphia, per ton	2.05@2.90	2.05@2.90	1.40@2.25
Kansas City, Mo. at plant	2.40	2.40	**.70** ton at pit
Pittsburgh, per ton, f.o.b.	.85	1.05	1.25

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are per cu.yd. delivered. Weight 1½ tons per cu. yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
New York, Limestone	$3.25@3.50	$3.25@3.50
Chicago, Limestone	**2.10@2.25**	**2.10@2.25**
St. Louis, per ton, f.o.b.	1.73	1.73
Dallas	3.25	3.40
San Francisco, Trap rock, bunkers (2,400)	1.70	1.70
Boston, per ton	2.25	2.25
Minneapolis, Limestone, per ton	2.25	2.25
Kansas City, Limestone, at plant, (2,450)	*2.00*	*2.00*
Denver, Granite (2,700)	2.50	2.50
Seattle, (2,700)	1.90	1.90
Atlanta, per ton	3.00	3.00
Cincinnati, per ton	2.25	2.25
Los Angeles, per ton, f.o.b.	1.80	1.80
Detroit, Limestone, per ton	2.50	*2.60*
Baltimore	2.75	2.85
Montreal, per ton		2.10
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
Cleveland, per ton	3.00	3.00
Birmingham, Limestone	2.50	2.50

CRUSHED SLAG—Price of crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.20	1.20	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	....	1.25

LIME—Prices delivered to job:

	Hydrated, per Ton—Finishing	Hydrated, per Ton—Common	Lump, per Barrel—Finishing	Lump, per Barrel—Common
New York	$21.00@22.00	$14.00@15.00	$4.00@4.10*	$3.15@3.25*
Chicago	20.00	18.00	.....	1.50†
St. Louis	24.00	18.00	.....	15.00‡
Boston	19.50	13.50	3.85*	**3.00***
Dallas	20.00	.....	.....	18.00‡
Cincinnati	16.80	13.20	.....	13.20‡
San Francisco	27.50	24.50	.....	1.70†
Minneapolis	25.50	21.00	.....	1.70†
Denver	**32.00**	24.00	.....	2.75@3.00*
Detroit	19.20	14.80	2.20†	2.20†
Seattle, paper sacks	24.00	.....	.....	2.80*
Los Angeles	26.00	*18.00*	2.40†	19.00‡
Baltimore	20.00	14.00	2.55†	.....
Montreal	21.00	21.00	.....	**15.00‡**
Atlanta	17.50	15.00	2.30†	2.10†
New Orleans	.....	.....	.....	2.00†
Philadelphia	22.00	15.00	.....	.....
Kansas City	18.00	18.00	2.50†	2.15†
Birmingham	*22.00*	16.00	2.40†	1.85†
Pittsburgh	22.00	18.00	.....	.....

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

NATURAL CEMENT—Prices per bbl. delivered to contractors, without charge for bags:

Minneapolis, Rosendale	*$1.50*
Kansas City, Ft. Scott	1.72
Cincinnati, Utica	1.92
St. Louis, Carney	2.60
Birmingham, Magnolia pozzolan cement	

PORTLAND CEMENT—Prices per bbl. delivered to contractors, in carloads, *without charge for bags.* Cash discount not deducted.

	June 7, 1928	One Month Ago	One Year Ago
New York	$2.25@$2.35	$2.25@$2.35	$2.35@$2.50
Jersey City	2.35	2.35	2.13f.o.b.
Boston	2.25	2.25	2.30
Chicago (f. o. b.)	2.05	2.05	2.05
Pittsburgh (f. o. b.)	2.04	2.04	2.04
Cleveland (f. o. b.)	2.24	2.24	2.24
Detroit (f. o. b.)	1.90	1.90	2.15
Indianapolis, (f. o. b.)	2.19	2.19	2.19
Milwaukee (f. o. b.)	2.20	2.20	2.20
Duluth (f. o. b.)	2.04	2.04	2.04
Peoria (f. o. b.)	2.22	2.22	2.22
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Davenport (f. o. b.)	2.24	2.24	2.24
St. Louis	2.45	2.45	2.05f.o.b
San Francisco	2.41	2.41	2.51
New Orleans	*2.50*	2.50	2.40
Minneapolis (f. o. b.)	2.22	2.22	2.22
Denver	2.85	2.85	2.85
Seattle	2.70	2.70	2.65
Dallas	2.40	2.40	2.05f.o.b
Atlanta	2.30	2.30	2.35
Cincinnati (f. o. b.)	2.22	2.22	2.32
Los Angeles	2.66	2.66	2.56
Baltimore	2.65	2.65	2.50
Birmingham	2.60	2.60	2.40
Kansas City, Mo.	*2.50*	2.50	2.10f.o.b
Montreal (f. o. b.)	1.41	1.41	1.36
Philadelphia	2.31@2.41	2.31@2.41	2.40
St. Paul (f. o. b.)	2.22	2.22	2.22
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b., to contractors:

Buffington, Ind.	$1.80	Richard City, Tenn.	$1.85
Universal, Pa.	1.80	North Birmingham, Ala.	1.45
Steelton, Minn.	1.85	Leeds, Ala.	1.65
Fordwick, Va.	2.05	Hannibal, Mo.	1.90
Mitchell, Ind.	1.90	Lehigh Valley District	1.75
Iola, Kan.	1.85	Wyandotte, Mich.	1.65
Mason City, Ia.	1.80	Alpena, Mich.	1.60
La Salle, Ill.	1.90	Kingsport, Tenn.	2.05
Hudson, N. Y.	1.75	Clinchfield, Ga.	1.65

E. N.-R. Prices of Construction Materials

WIRE REINFORCEMENT FOR CONCRETE—Price per 100 sq.ft. in carloads at mills; from warehouses per 100 sq.ft. in lots of 10,000 sq.ft. or over.

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York*	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.18	1.66	1.67	1.91
093	45	1.98	2.03	2.79	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.13	3.14	3.15	....
180	78	3.35	3.43	4.73	3.60	3.47	....
245	103	4.43	4.53	6.24	4.75	4.58	....
287	119	5.12	5.24	7.20	5.50	5.26	6.35
336	138	5.93	6.07	8.36	6.37	6.11	....
395	160	6.88	7.04	9.68	7.38	7.12	....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher.

*Delivered to job. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

BARS, CONCRETE REINFORCING—Pittsburgh and Birmingham prices are for large mill lots, per 100 lb., f.o.b. mill. In other cities listed, prices are per 100 lb., for bars delivered from warehouse stocks.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York	Warehouse: Chicago	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
¾ and larger	$1.95	$2.05	$3.25*	$2.30@2.75	$3.15	$3.75	$2.25
⅝	2.05	2.15	3.35*	2.40@2.85	3.25	3.95	2.35
½	2.15	2.25	3.45*	2.50@2.95	3.35	3.95	2.45
⅜	2.35	2.45	3.65*	2.70@3.15	3.55	4.10	2.65
¼	2.95	3.05	4.25*	3.30@3.75	4.15	4.75	3.25

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923. *250 to 3,999 lb.

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Weight in Pounds per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$19.00	$19.50	*$16.00*	$16.00	$18.50	$21.50
2.5	20.00	21.50	*17.00*	17.00	19.50	24.00
3.0	22.00	24.50	*19.00*	18.50	22.00	
3.4	23.50	27.50	*20.50*	20.00	24.00	30.50

BRICK—Contractors price, delivered, per M, is as follows:

	Common	Paving F.O.B.: 3x8¼x4-in.	Paving F.O.B.: 3¼x8¼x4-in
New York	$17@20	$45.00	$51.00
Chicago	12.00	42.00	45.00
St. Louis, salmon	14.00	40.00 del.	42.50del.
Denver, salmon	10@12	....	....
Dallas	15.00	35.00	....
San Francisco	13.00	....	....
Los Angeles	11.00	....	....
Boston	17.50	45.00 del.	*51.00* del.
Minneapolis	13.50	....	....
Kansas City	14.00	....	33.00
Seattle	14.00	....	55.00
Cincinnati	18.00	40.00	45.00
Montreal	20.33	100.00*	....
Detroit	15.50	35.50	38.50
Baltimore	15.00	40.00	45.00
Atlanta	12.00	40.00	....
New Orleans	*15.00*	60.00	75.00
Birmingham	*15.00*	50.00 del.	60.00del.
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	....	....
Cleveland	14@16	....	....

*Imported.

HOLLOW TILE—Price of hollow building tile per block delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Boston	$0.0775	.....	**$0.138**	.....	$0.2375
Minneapolis	.0842	.....	.1476	.....	.2441
Cincinnati	.074	.....	.136	.....	.205
Kansas City	**.088**	.....	**.158**	.....	**.242**
Denver	.085	.....	.155	.....	.22
Seattle	.10	.....	.18	.....	.26
Los Angeles	.085	.....	.172	.....	.285
New Orleans	.09	.....	.165	.....	.245
Detroit	.092	.....	.174	.....	.244
Montreal	.12	.....	.22	.....	.315
Baltimore	.095	.....	.173	.....	.232
Atlanta	.0808	.....	.1516	.....	.2232
Dallas	.0985	$0.1205	.1785	$0.284	.....
Birmingham	.09	.127	.174	.....	.....
Pittsburgh	.068	.....	.1175	.....	.1726
Cleveland	.06	.....	.135	.....	.....
New York	*.0973*	*.1459*	*.1824*	*.2313*	*.3084*
Chicago	.076	.104	.142	.182	.202
Philadelphia	.11	.....	.22	.....	.34
St. Louis	.078	.105	.145	.175	.210
San Francisco	.108	.156	.255	.....	.....
Perth Amboy, N. J. (f.o.b.)	.....	.....	.....	.252	.312

STRUCTURAL MATERIAL—Pittsburgh and Birmingham prices are for large mill lots, per 100 lb., f.o.b. mill. At other cities listed, quotations apply on less-than-carload lots delivered from warehouse stocks:

	Pittsburgh	Birmingham	Warehouse: New York	Warehouse: Dallas	Warehouse: St. Louis	Warehouse: Chicago	Warehouse: San Francisco
Beams, 3 to 15 in.	$1.85	$2.05	$3.30*	$5.00	$3.25	$3.10	$3.25
Channels, 3 to 15 in.	1.85	2.05	3.30*	5.00	3.25	3.10	3.25
Angles, 3 to 6 in., ¼ in. thick	1.85	2.05	3.30*	5.00	3.25	3.10	3.25
Tees, 3 in. and l'rg'r	1.85	2.05	3.30*	5.00	3.25	3.10	3.25
Plates, ¼ in. thick and heavier	1.85	2.05	3.30*	5.00	3.25	3.10	3.25

*250 to 3,999 lb.

RIVETS—The following quotations are per 100 lb., full packages, delivered from warehouse:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill	Warehouse: New York	Warehouse: Chicago	Warehouse: St. Louis	Warehouse: San Francisco	Dallas
¾ in.	$2.90	$5.00	$3.60	$3.75	$5.75	$5.00

CONE-HEAD BOILER

½ in.	**$3.00**	$5.00	$3.60	$3.90	$5.75	$5.00

NAILS—The following quotations are per 100 lb. keg delivered from warehouse stocks, also Pittsburgh mill base:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55@$2.65	3.10	$3.10	$3.60	$4.00	$2.83½	$4.95
Cut	2.80	3.30	....	5.00	5.00	....	5.00

SHIP SPIKES—Current prices per 100 lb. delivered from warehouse:

In.	San Francisco: Galv	San Francisco: Black	Seattle Black
½	**$7.55**	**$5.80**	$7.75
⅝	6.85	5.10	5.65
¾	6.70	4.95	5.50

Pittsburgh base in lots of 200 kegs or more, $3.00 per 100 lb.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93¾ per square to contractors in carloads f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carloads f.o.b. New York.

Strip shingles (4 in.) f.o.b. New York, in carloads to contractors, are $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carloads:

Tar felt per 100 lb.	$2.94½
Asphalt coating, per gal.	31¼
Asphalt felt, per 100 lb.	3.09

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, discount from jobbers' list at New York warehouses:

Single Thickness		Double Thickness	
AA	83%	AA	83%
A	88%	A	88%
B	90%	B	90%

SHEETS—Quotations are per 100 lb. in various cities delivered from warehouse stocks, also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	*$2.00@$2.10*	$3.60	$3.50	$3.85	$3.90*
No. 12	*2.05@2.15*	3.65	3.55	3.90	3.95*
No. 14	*2.15@2.20*	3.70	3.60	3.95	4.00*
No. 16	*2.25@2.30*	3.80	3.70	4.10	4.10*
Black					
Nos. 18 to 20	2.70@**2.80**	*4.05*	3.75	4.75	4.00
No. 22	2.85@**2.95**	*4.20*	3.90	4.90	4.15
No. 24	2.90@**3.00**	*4.25*	3.95	4.95	4.20
No. 26	3.00@**3.10**	*4.35*	4.05	5.00	4.30
No. 28	3.15@**3.25**	*4.50*	4.20	5.20	4.45
Galvanized					
No. 10	*2.85@2.95*	*4.40*	4.10	....	4.25
Nos. 12 to 14	*2.95@3.05*	*4.50*	4.20	4.90	4.35
No. 16	*3.05@3.15*	*4.60*	4.30	5.00	4.45
No. 18	*3.20@3.30*	*4.75*	4.45	5.15	4.60
No. 20	*3.35@3.45*	*4.90*	4.60	5.30	4.75
No. 22	*3.50@3.50*	*4.95*	4.65	5.35	4.80
No. 24	*3.55@3.65*	*5.10*	4.80	5.50	4.95
No. 26	*3.80@3.90*	*5.35*	5.05	5.75	5.20
No. 28	*4.05@4.15*	*5.60*	5.30	6.00	5.45

Extra for corrugated sheets, 15c. per 100 lb. *250 to 3,999 lb.

LINSEED OIL—These prices are for raw oil in barrels, f.o.b. in 1 to 4-bbl. lots:

	New York	Chicago	Minneapolis
Per pound	**$0.112**	**$0.107**	**$0.117**

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Prices of rough Douglas fir No. 1 common, at yards; prices delivered to contractor at site of job, $1.50 to $5 per M. ft. additional:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Prices, f.o.b., in carloads, per M. ft. b.m.; delivered to job in truckloads, $10 per M. ft. additional:

	20 Ft. and Under No. 1 Long-Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$57.50	$39.50
3x10 to 10x10	46.00	39.50
3x12 to 12x12	56.00	39.50
3x14 to 14x14	.....	39.50
3x16 to 16x16	.....	40.50

New York—Prices per M. ft., b.m., wholesale, for rough, long-leaf, yellow-pine timbers in quantities of 35,000 ft. or more, within lighterage limits:

	20 Ft. and Under Long-Leaf Yellow Pine	22-24 Ft. Long-Leaf Yellow Pine
3x4 to 8x8	$41.00@$43.00	$42.00@$44.00
3x10 to 10x10	48.00@ 50.00	49.00@ 51.00
3x12 to 12x12	55.00@ 57.00	56.00@ 58.00
3x14 to 14x14	63.00@ 65.00	64.00@ 66.00
3x16 to 16x16	75.00@ 77.00	76.00@ 78.00

Other Cities—Delivered to job:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Boston	$47.50	$47.00	$47.50	$50.00	$56.00	$54.50
Seattle	.....	23.00	.....	.....	.....	23.00
New Orleans	40.00	56.00	.....	.....	61.00	61.00
Baltimore	36.00	50.25	54.00	61.00	75.00	50.50
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00
Montreal	50.00	55.00	.....	.....	49.00	48.00
Los Angeles	.....	39.50	.....	32.00	.....	39.50
Denver	.....	31.25	.....	.....	.....	32.25
Minneapolis	51.00	46.25	36.25	.....	53.00	47.75
Atlanta	31.00	.....	.....	.....	45.00	.....
Dallas	57.50	.....	.....	.....	57.50	.....
Kansas City, Mo	40.50	38.75	.....	.....	53.50	38.75
Birmingham	35.00	.....	.....	.....	55.00	.....
Philadelphia	55.00	37.00	42.00	43.00	65.00	37@38
Detroit	55.00	55.00	.....	.....	65.00	65.00
St. Louis	43.00	.....	.....	.....	50.00	.....

	1x10 In. x 16 Ft. and Under, Rough			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Boston	$43.00	$42.50	$44.00	$48.00	$47.50
Seattle	.....	22.00	.....	.....	23.50
New Orleans	36.00	.....	.....	44.00	.....
Baltimore	56.00	45.00	45.00	35.00	48.00
Cincinnati	27.00	32.00	30.00	28.00	45.00
Montreal	45.00	48.00	40.00	85.00	70.00
Los Angeles	.....	33.50	.....	.....	47.50
Denver	.....	32.25	31.25	.....	31.25
Minneapolis	46.00	40.00	35.75	46.00	41.00
Atlanta	40.00	.....	.....	40.00	.....
Dallas	.....	.....	.....	57.50	.....
Kansas City, Mo	47.75	40.75	.....	41.75	35.75
Birmingham	36.00	.....	.....	48.00	.....
Philadelphia	30.00	36.50	36.00	50.00	36.50
Detroit	40.00	.....	.....	38.00	.....
St. Louis	41.50	.....	.....	31.50	.....

*Long-leaf yellow pine. †Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The base price f.o.b. Pittsburgh for large mill lots is $2.25@$2.35 per 100 lb.

CONCRETE BLOCKS—Standard, 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.15	Boston	18@.20
New Orleans	....	Minneapolis	.14
Brooklyn and Queens	.16@.18	Philadelphia	18@.25
Pittsburgh	.18	Cleveland	17@.18

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized, are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (add to list)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅜-in., 8-ft.; ½-in., 6-ft.; ⅝-in., 4½-ft.; 1-in., 3½-ft.; 1¼-in., 2-ft. 10-in.; 1½-in., 2-ft. 4-in. Following are prices per pound for ¾-in. and larger delivered in 1,200-ft. coils:

Boston	$0.25	New Orleans	$.23½
New York	.24	Los Angeles	.25
Chicago	.21	Seattle	.21½
Minneapolis	.23	St. Louis	.21½
San Francisco	.21½	Montreal	.24½
Atlanta	.25	Detroit	.24½
Denver	.24	Baltimore	.22½
Cincinnati	.21	Kansas City	.29½
Dallas	.21	Birmingham	.35@.40
Philadelphia	.25	Cleveland	.30

EXPLOSIVES—Prices per pound for dynamite delivered in small lots:

	Gelatin 40%	Gelatin 60%
New York (Special gelatin in case lots.)	$0.26	$0.2825
Boston	.25	.275
Kansas City	.2025	.2223
Seattle	.16	.185
Chicago (Quantities above 500 lb., but less than a ton.)	.195	.22
Minneapolis	.1967	.2123
St. Louis	.20	.225
Denver (f.o.b.)	.1925	.2150
Dallas	.2325	.2525
Los Angeles (f.o.b. San Fernando Arsenal)	.1875	.2225
Atlanta	.225	.24
Baltimore	.215	.2375
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham (f.o.b.)	.155	.185
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	5.15@ 5.20
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, liquid, cylinders, per lb.	.05½@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10*

* F.o.b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload for structural steel, 50,000 lb.; for other iron or steel products, 80,000 lb.